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# MEDUSAE OF THE WORLD

## VOLUME I

## THE HYDROMEDUSAE

BY

ALFRED GOLDSBOROUGH MAYER

WASHINGTON, D. C.

PUBLISHED BY THE CARNEGIE INSTITUTION OF WASHINGTON

1910

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History; the American Museum of Natural History; Columbia University, the National Museum at Washington, and the Museum of the Brooklyn Institute of Arts and Sciences. Through these facilities I have been enabled to review nearly all of the published works upon medusæ, but the review of literature can not pretend to completeness for 1907 and 1908, although all papers of those years which the author could discover are recorded.

Moreover, Profs. William K. Brooks and Louis Murbach have been so kind as to lend some of their original drawings, which are reproduced in this work, and the following gentlemen have generously granted permission for the reproduction of figures from their published works, thus enabling us to present text-figures of many forms which would otherwise have been represented merely by descriptions: Dr. Alexander Agassiz, Director of the Museum of Comparative Zoology at Harvard University; Dr. Henry B. Bigelow, of Harvard; Dr. R. P. Bigelow, of the Massachusetts Institute of Technology; Prof. Edward T. Browne, of the University of London; Prof. Dr. Carl Chun, of Leipzig; Prof. Dr. S. Goto of Tokyo; Geheimrath Prof. Dr. Ernst Haeckel, of Jena; Prof. C. W. Hargitt, of Syracuse University; Prof. Dr. Cl. Hartlaub, of Helgoland; Prof. W. C. M'Intosh, of Aberdeen University; Prof. Dr. Otto Maas, of München; Prof. C. C. Nutting, of Iowa; Prof. Henry F. Perkins, of Vermont; and Prof. Dr. Ernst Vanhöffen, of Kiel.

I have always felt that each working naturalist owes it as a duty to science to produce some general systematic work, and this has been an actuating motive in the production of this book. But chiefly have I been moved to the task through respect for the wishes of my generous friend and master in science, Alexander Agassiz. Nor can one remain insensible to the rare grace of form and delicate beauty of color of these creatures of the sea, associated as their study is with memorials of the labors of a host of distinguished naturalists. Dry though these pages must be to the reader, to the writer they are replete with memories of the ocean in many moods, of the palm-edged lagoons of coral islands sparkling in the tropic sun, of the cold, gray waters of the northern sea bestrewn with floating ice, of days of withering calm in the heat of the torrid zone, and of adventure in the hurricane; all centering around the absorbing study of the medusæ. Love, not logic, impels the naturalist to his work.

This book attempts to present a new classification of the medusæ. With every respect for Haeckel's great work, it has appeared to me that its subdivisions are often too precise to be convenient, and too artificial to accord with nature. Moreover, many of Haeckel's genera are founded upon intergrading characters, and are thus imperfectly separated. The young of many medusæ appear in one genus, and the adults in another. The aim of Haeckel's system is to emphasize distinctions, whereas my aim is to indicate relationships. I therefore attempt to separate genera upon positive, not upon relative, distinctions. For example, if we define one genus as having a narrow manubrium (*Margelis*), and another as having a wide manubrium (*Bougainvillia*), we must either institute a third genus for newly-discovered medusæ with manubria of moderate width or place them doubtfully in one or the other of the genera of the extreme members of the series.

On the other hand, if we define one genus as having eight tentacles, and another as having nine or more tentacles, there can be no confusion between them, for the difference, although slight, is positive and numerical, not qualitative and intergrading.

I have not described hydroids which do not produce free-swimming medusæ, although I grant it is wholly illogical to admit *Podocoryne* into a system which excludes *Hydractinia*, or to include only those species of *Stylactis* which produce

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medusæ and to exclude those which produce sessile gonophores. Nevertheless this should be clearly understood and must be accepted as an artificial limitation of the work.

I have thus attempted to describe only such hydroids as are known to produce medusæ, and have endeavored to bring the systematic arrangement of the medusæ more nearly into accord with that of the hydroids. A strictly natural system including both hydroids and medusæ can not be constructed, for many of the hydroids remain undetermined. Moreover, dissimilar hydroids (*Syncoryne*, *Stauridium*) may give rise to similar medusæ (*Sarsia*); or the reverse may be the case, as in the medusæ of *Bougainvillia* and *Nemopsis*, or that of the two sorts of medusæ (*Sarsia* and *Cladonema*) which may arise from hydroids of *Stauridia*.

These and many other cases of a similar nature interpose a barrier to our attempts to invent a natural system which includes all hydroids and medusæ within its embrace. At present, I believe, we must content ourselves with a compromise between a natural and an artificial arrangement, confiding in the belief that as more and more of the hydroids are discovered it will become correspondingly more possible to arrange the medusæ in a natural system. After consultation with Prof. C. C. Nutting we have mutually decided that the promulgation of such a system is at present inadvisable. Such a system has, indeed, been proposed by von Lendenfeld, 1884 (Zool. Anzeiger, Bd. 7), but has gained no acceptance.

Much confusion has been introduced through the habit, in vogue among marine expeditions, of sending all of the medusæ to one specialist and the hydroids to another. Thus the sessile and the reproductive stages of the same animals are worked upon independently from different view-points by different men.

I am inclined to regard the Trachymedusæ and Narcomedusæ as being transformed actinulæ, for they commonly develop through an actinula larva in which the bell grows out as a collar-like, or intertentacular lappeted expansion from the sides of the body *after* the tentacles have appeared, and the tentacles of the actinula become those of the medusa. The medusa of the Anthomedusæ and Leptomedusæ is formed upon a different plan, for the tentacles grow outward from the bell-margin after the bell has developed. I believe, therefore, that the bell of the Trachymedusæ and Narcomedusæ is not homologous with that of the Anthomedusæ and Leptomedusæ. It is evident that the entodermal otoliths of the Trachymedusæ and Narcomedusæ are not homologous with the ectodermal otoliths of Leptomedusæ. Budding and alternation of generations occur in both classes of veiled medusæ.

I believe that the medusa-shape has been acquired independently in the Trachylina and Leptolina forms of veiled medusæ.

The colored plates contained in this volume consist of drawings, from life, of medusæ of the Atlantic coast of the United States. The text-figures, on the other hand, are chiefly outline tracings from the illustrations of many authors; and are presented in order to spare the reader the trouble of consulting numerous scattered works of reference. These outline copies of previously-published drawings of medusæ were carefully traced from the originals by Mr. Carl Kellner, artist of the Tortugas Marine Laboratory of the Carnegie Institution.

Other outline figures are from life, and the majority of these were drawn by the author while studying at Mousehole, Cornwall, England, and at the Naples Zoological Station during the autumn and winter of 1907 and 1908.

This book aims to be something more than an old-fashioned systematic treatise, for it attempts to record, if not to review, all works upon the embryology, cytology, œcology, physiology, etc., of all forms coming within the scope of the text.

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Many of the medusæ are modified more or less profoundly by environmental conditions, and this gives rise to numerous local races, the determination of the relationships between which is all but impossible in the present state of our knowledge. Experimental work in this field is in its infancy, yet the few observations of Hallez on *Bougainvillia* and of Browne in his experiments in maintaining various hydroids under different conditions in aquaria suggest that the results of more extended studies will be of great benefit to the systematist in determining the natural limitations of species. A striking example of the profound effect of environmental changes is seen in the experiments of Goldfarb, 1906, upon *Eudendrium*, wherein he showed that after the regenerative process had entirely ceased in the dark, it could be recalled into activity by an exposure of only five seconds to the daylight.

At present the natural classification of the species of such genera as *Obelia*, *Phialidium*, *Eutima*, *Bougainvillia*, etc., is impossible, and the Linnean system is inadequate to the task of expressing their actual relationships. Indeed, with the exception of the sponges and corals, there is no phylum of the animal kingdom more difficult to classify than the medusæ.

In a work of this magnitude there must needs be both errors and omissions, and for these I can but present my apologies in advance of their discovery, trusting that all such will soon be discovered and announced, and that science may be more advanced than hindered through the publication of this book. I trust that none of my esteemed contemporaries will feel aggrieved at such criticisms of their labors as may appear in the following pages, for should anyone find cause for such offense, he may console himself in the fact that I am obliged to confess to having found more to criticize and amend in my own previously-published papers than in those of any other living naturalist.

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## HYDROMEDUSÆ OR VEILED MEDUSÆ.

Medusæ with a velum, or diaphragm, which partially closes the marginal opening of the bell. When ripe the sexual products are found in the ectoderm.

With a double marginal nerve-ring, one above and one below the velum.

Without gastric filaments. Development either direct from actinula larvæ or through alternation of generations from hydroids.

### Order 1. ANTHOMEDUSÆ Haeckel, 1879.

Hydromedusæ with gonads in the ectoderm of the manubrium. Without otocysts. The hydroids are of the Tubularian order.

#### Family No. 1, CODONIDÆ.

Anthomedusæ with ring-like gonad encircling the manubrium. Four to six simple, unbranched radial-canals. Simple, unbranched tentacles.

#### Subfamily No. 1, SARSIANÆ.

Some or all of the tentacles arise singly, not in clusters, from bell-margin.

PACHYCORDYLE, Weismann, 1883 = *Parvanemus* (?), Mayer, 1904.
Degenerate medusæ without tentacles, radial or circular canals. Hydroid: *Pachycordyle* Weismann.

AMALTHÆA, Schmidt, 1854.
Four rudimentary tentacles, four radial-canals, and a ring-canal. Hydroid: *Corymorpha*.

PENNARIA, Oken, 1815; Goldfuss, 1820 = *Globiceps*, Haeckel, 1879.
Similar to *Amalthæa*, but the hydroid is *Pennaria*.

TRICHORHIZA, Russell, 1906.
Medusa resembles *Pennaria*, but the hydroid is *Trichorhiza*.

STEENSTRUPIA, Forbes, 1846 = *Euphysa*, Forbes, 1848 = *Euphysora*, Maas, 1905.
Four radially situated tentacles, one of which is long, the other three short. Bell radially symmetrical. Hydroid: *Corymorpha*.

HYBOCODON, L. Agassiz, 1862 = *Hybocodon* + *Amphicodon*, Haeckel, 1879.
One or more well-developed tentacles arise from base of one of the four radial-canals. With rudimentary tentacles at the bases of the three other radial-canals. Bell asymmetrical. Hydroid: *Hybocodon* Agassiz.

MICROCAMPANA, Fewkes, 1889.
With one long and five short tentacles, arising at ends of six radial-canals.

DICODONIUM = *Dicodonium* + *Dinema*, Haeckel, 1879.
Two well-developed and two rudimentary tentacles. No meridional lines of nettle-cells over exumbrella.

SARSIA, Lesson, 1843 = *Codonium* + *Sarsia* + *Syndictyon*, Haeckel, 1879.
Four equally developed tentacles with abaxial, ectodermal ocelli. No meridional lines of nettle-cells over the exumbrella. Hydroid: *Syncoryne*.
*Stauridiosarsia* new subgenus. Medusa similar to *Sarsia*, but the hydroid is *Stauridia*.

HYDRICHTHYS, Fewkes, 1888.
Medusa resembles *Sarsia*, but there are no ectodermal ocelli upon the tentacle-bulbs. Hydroid: *Hydrichthys*, Fewkes; commensal or parasitic upon fish.

EUCODONIUM, Hartlaub, 1907.
Medusa resembles *Sarsia*, but stomach is mounted upon a gelatinous peduncle. The four tentacles terminate each in a knob-shaped extremity.

ECTOPLEURA, L. Agassiz, 1862 (sens. ampl.).
With two or four tentacles. Eight meridional lines of nettle-cells over the exumbrella. Hydroid: *Ectopleura*.

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CORYNITIS, McCrady, 1857.
Four knobbed tentacles. Manubrium cruciform in cross-section. Ocelli upon tentacle-bulbs. Hydroid: *Syncoryne* (Hargitt).

SLABBERIA, Forbes, 1846=*Slabberia*+*Dipurena*+*Bathycodon*, Haeckel, 1879.
Four knobbed tentacles. Manubrium tubular and encircled by two or more ring-like gonads. Hydroid: *Syncoryne*.

### Subfamily No. 2, MARGELOPSINÆ.

Four radially placed clusters of marginal tentacles. No oral tentacles. A ring-like gonad encircles the stomach. Four simple, unbranched radial-canals. Hydroids are pelagic Tubularians, and the medusæ arise by budding from their sides.

MARGELOPSIS, Hartlaub, 1897.
Characters of the medusa are those of the subfamily. Hydroid: *Margelopsis*, in which the tentacles are disposed in definite circlets.

PELAGOHYDRA, Dendy, 1903.
Medusa similar to *Margelopsis*. Hydroid: *Pelagohydra*. Its tentacles arise irregularly from sides of the hydranth, and are not disposed in definite circlets.

### Family No. 2, CLADONEMIDÆ.

Tentacles branch dichotomously or complexly, or give rise to a linear series of nematocyst-bearing filaments along their abaxial sides. Gonads ring-like, or segregated upon the interradial and adradial sides of the manubrium.

### Subfamily No. 1, PTERONEMINÆ.

Manubrium without oral tentacles.

ZANCLEA, Gegenbaur, 1856=*Zanclea*+*Gemmaria*, Haeckel, 1879.
With two or four tentacles, each of which gives rise to an abaxial row of nematocyst-bearing branches. With meridional rows of nettle-cells upon the exumbrella. No ocelli upon the tentacle-bulbs. No brood-pouch above the stomach. Hydroid: *Gemmaria* McCrady; Allman.

ZANCLEOPSIS, Hartlaub, 1907.
Similar to *Zanclea*, but without meridional lines of nettle-cells over the exumbrella. With ectodermal ocelli upon the outer sides of the tentacle-bulbs.

PTERONEMA, Haeckel, 1879.
Similar to *Zanclea*, but with a brood-sac above the stomach. Four tentacles.

ELEUTHERIA, Quatrefages, 1842.
Four to six bifurcated tentacles, and an equal number of simple unbranched radial-canals. There is an ectodermal brood-sac above, but not connected with the stomach. The medusa is hermaphroditic and the germ-cells develop in the brood-sac. Hydroid: *Clavatella* Hincks.

MNESTRA, Krohn, 1853; Günther, 1903.
Degenerate medusa parasitic upon *Phyllirrhoë*. Four to no tentacles, each with an abaxial line of nettle-warts. Four perradial meridional lines of nettle-cells over the exumbrella. Four radial-canals. Throat is blocked by a cavernated mass of entoderm.

### Subfamily No. 2, DENDRONEMINÆ.

Manubrium with oral tentacles.

CTENARIA, Haeckel, 1879.
Two marginal tentacles with abaxial filaments. Four bifurcated radial-canals. Simple oral tentacles. Brood-sac above the stomach.

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CLADONEMA, Dujardin, 1843.
Four or five bifurcated or eight to ten simple radial-canals. Branched marginal tentacles. Simple oral tentacles. No brood-sac above the stomach. Hydroid: *Stauridia* Dujardin.

DENDRONEMA, Haeckel, 1879.
Similar to *Cladonema*, but with branched oral tentacles and with brood-sac above stomach.

**Family No. 3, OCEANIDÆ, sensu Vanhöffen.**

Anthomedusæ in which the gonads are segregated and developed upon the interradial or adradial sides of the manubrium. With unbranched marginal tentacles. Mouth with four lips.

**Subfamily No. 1, TIARINÆ.**

Unbranched radial-canals. Marginal tentacles separate; not grouped into clusters. No oral tentacles. Tentacles hollow. When present the ectodermal ocelli are upon the abaxial sides of the tentacle-bulbs. With the exception of *Calycopsis* all of the genera have four radial-canals.

PROTIARA, Haeckel, 1879 = *Halitiara*, Fewkes, 1882.
Four radially placed, well-developed tentacles. Four interradial gonads with smooth outer surfaces. With or without marginal cirri. External surfaces of gonads smooth. Four cruciform, simple lips. No ocelli on the velar sides of the tentacles.

HETEROTIARA, Maas, 1905.
Eight or more tentacles. The ring-canal gives rise to blindly-ending centripetal vessels.

STOMOTOCA, L. Agassiz, 1862 = *Amphinema* + *Stomotoca* + *Codonorchis*, Haeckel, 1879.
Two well-developed and many rudimentary tentacles. External surfaces of the adradial gonads are thrown into transverse folds. Hydroid: *Perigonimus*.

DISSONEMA, Haeckel, 1879.
Similar to *Stomotoca*, but the gonads finally migrate outward along the four radial-canals.

PANDEA, Lesson, 1843.
Four or more tentacles. Gonads four interradial, folded ridges on the sides of the stomach but these gonads are not completely separated in the four principal radii. Hydroid: *Dendroclava* (? ?).

TURRIS, Lesson, 1843 = *Tiara* + *Turris* + *Catablema*, Haeckel, 1879.
Four or more tentacles. Four interradial horseshoe-shaped gonads on the stomach wall. These are composed of more or less fused ridges or network-like swellings. They are completely separated in the four principal radii. Hydroid: *Clavula* Wright.

CONIS, Brandt, 1834; Haeckel, 1879.
Similar to Pandea, but the tentacle-bulbs give rise to abaxially-placed clubs which bear ocelli.

CALYCOPSIS, Fewkes, 1882.
Sixteen simple, separate radial-canals. Eight transversely folded, adradial gonads. Ring-canal simple.

**Subfamily No. 2, MARGELINÆ.**

With four unbranched radial-canals. With oral tentacles, or nematocyst-knobs, upon the lips. Tentacles solid. When present the ectodermal ocelli are upon the inner (velar) sides of the tentacles.

CYTÆIS, Eschscholtz, 1829 = *Cytæis* + *Cubogaster*, Haeckel, 1879.
Four simple marginal tentacles. With simple, unbranched, oral tentacles.

PODOCORYNE, Sars, 1846 = *Dysmorphosa* + *Cytæandra*, Haeckel, 1879.
Eight or more simple marginal tentacles. With simple, unbranched, oral tentacles. Hydroid: *Podocoryne*. When present the peduncle above the stomach is solid and gelatinous.

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TURRITOPSIS, McCrady, 1856.
Eight or more simple marginal tentacles. The entodermal walls of the radial-canals above the stomach are composed of vacuolated cells forming a peduncle-like base for the stomach. The mouth is studded with a row of nematocyst-bearing knobs. With ectodermal ocelli on the velar sides of the tentacles near their bases. Hydroid: *Dendroclava* (Brooks).

OCEANIA *sensu* Kölliker, 1853; Gegenbaur (in part) 1856.
Medusa similar to *Turritopsis*, but with solid gelatinous, *non*-vacuolated peduncle above the stomach. Hydroid: *Clava*-like.

STYLACTIS, Allman, 1864.
Degenerate medusæ, with four to eight rudimentary marginal tentacles and no oral tentacles. Hydroid: *Stylactis*.

THAMNOSTYLUS, Haeckel, 1879.
With two simple, marginal tentacles, and with branched oral tentacles.

THAMNITIS, Haeckel, 1879.
Four radially placed, simple, marginal tentacles, and branched oral tentacles.

LYMNOREA, Péron and Lesueur, 1809 = *Limnorea* + *Thamnostoma*, Haeckel, 1879.
Eight or more simple, marginal tentacles. Branched oral tentacles.

BOUGAINVILLIA, Lesson, 1843 = *Margelis* + *Lizusa* + *Hippocrene*, Haeckel, 1879.
With branched oral tentacles. The marginal tentacles are grouped in four radial clusters. All of the tentacles are filiform. Hydroid: *Bougainvillia*.

NEMOPSIS, L. Agassiz, 1849.
Similar to *Bougainvillia*, but each cluster of marginal tentacles consists of a median pair of clavate tentacles flanked by filiform tentacles. Hydroid: *Bougainvillia*.

RATHKEA, Brandt, 1837 = *Lizzia* + *Lizella* + *Rathkea* + *Margellium*, Haeckel, 1879.
With eight clusters of marginal tentacles. Simple or branched oral tentacles. Ring-canal simple.

CHIARELLA, Maas, 1897.
Sixteen (eight double) clusters of marginal tentacles. The ring-canal gives rise to centripetal vessels. Branched oral tentacles.

### Subfamily No. 3, DENDROSTAURINÆ.

With branched radial-canals. No oral tentacles. Marginal tentacles arise singly, and are not grouped into clusters. Tentacles hollow. No cirri or marginal clubs.

BYTHOTIARA, Günther, 1903.
Four bifurcated radial-canals and a ring-canal. Four interradial gonads.

SIBOGITA, Maas, 1904.
Four principal radial-canals, which branch complexly. Four interradial gonads. Ring-canal present.

NIOBIA, Mayer, 1900.
Four principal radial-canals, two of which bifurcate so that six canals reach the circular vessel. Four interradial gonads. The marginal tentacles develop into medusæ, and are cast off.

PROBOSCIDACTYLA, Brandt, 1838 = *Dyscannota* + *Dicranocanna* + *Willeta* + *Proboscidactyla*, Haeckel, 1879.
The four primary radial-canals give rise to simple or branched side branches. No ring-canal. With intertentacular lines of nematocysts upon the exumbrella above the bell-margin. Gonads on the adradial sides of the stomach extending outward along the sides of the four main radial-canals.

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WILLSIA, Forbes, 1846.
Similar to *Proboscidactyla*, but with six or more primary radial-canals. The hydroid belongs to the genus *Lar* Gosse.

## Order 2. LEPTOMEDUSÆ Haeckel, 1886.

Hydromedusæ with gonads upon the radial-canals. When present the otoliths are of ectodermal origin. The medusæ arise through alternation of generations from Campanularian hydroids.

### Family No. 1, THAUMANTIADÆ.

Leptomedusæ without lithocysts.

#### Subfamily No. 1, MELICERTINÆ.

With simple, unbranched radial-canals and an equal number of lips, without oral tentacles. Cirri or marginal clubs may or may not be present.

THAUMANTIAS, Eschscholtz, 1829 = *Tetranema* + *Thaumantias*, Haeckel, 1879.
Four or more tentacles. Four radial-canals. No marginal clubs or cirri. Hydroid: *Thaumantias*.

LAODICEA, Lesson, 1843 = *Octonema* + *Laodice*, Haeckel, 1879.
Four or more tentacles. Four radial-canals, with marginal clubs or cirri. Hydroid: *Cuspidella*.

MELICERTUM, Oken, 1815; *sensu* L. Agassiz, 1862 = *Melicertella* + *Melicertum*, Haeckel, 1879.
With eight or more tentacles. Eight radial-canals. No marginal clubs or cirri. Hydroid: *Melicertum* Agassiz.

MELICERTISSA = *Melicertissa* + *Melicertidium*, Haeckel, 1879.
Similar to *Melicertum*, but with marginal clubs or cirri between the tentacles.

ORCHISTOMA, Haeckel, 1879.
More than eight radial-canals. With or without marginal clubs or cirri.

TIMOIDES, H. B. Bigelow, 1904.
Four radial-canals. The ring-canal gives rise to blindly-ending centripetal diverticula. Numerous tentacles and cirri. Four gonads on the four radial-canals. Stomach mounted upon a peduncle.

#### Subfamily No. 2, POLYORCHINÆ.

The radial-canals give rise to branches which *end blindly* and do not connect with the marginal ring-canal.

STAURODISCUS, Haeckel, 1879.
With four radial-canals, each of which gives rise to two side branches, which end blindly.

PTYCHOGENA, A. Agassiz, 1862, 1865.
With four radial-canals which give rise to numerous blindly-ending side branches. Gonads leaf-shaped and developed upon the side branches of the radial-canals.

POLYORCHIS, A. Agassiz, 1862 to 1865.
With four radial-canals which give rise to numerous blindly-ending side branches. Numerous sac-like, sausage-shaped gonads attached to the radial-canals and to their side branches. Ring-canal simple. Bell-margin not cleft into lappets.

SPIROCODON, Haeckel, 1879 = *Goniomeandrus*, Kirkpatrick, 1903.
Similar to *Polyorchis*, but the ring-canal gives rise to blindly-ending, centripetal branches, and bell-margin is cleft into lappets.

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### Subfamily No. 3, BERENICINÆ.

The radial-canals give rise to branches which connect with the ring-canal.

CANNOTA, Haeckel, 1879.
With four radial-canals, each of which gives rise to two side branches which join the ring-canal.

CUVIERIA, Péron, 1807=*Berenice*, Haeckel, 1879.
With four main radial-canals which give rise to numerous non-dichotomous side branches. Gonads on the terminal ramuli of the canals.

DICHOTOMIA, Brooks, 1903.
With four main radial-canals which divide dichotomously two or more times. The gonads extend outward from the stomach over the canals.

DIPLEUROSOMA, Axel Boeck, 1866=*Tetracannota*, Mayer, 1900.
With three or more main radial-canals which give rise to non-dichotomous side branches. Gonads on the canals adjacent to the stomach. Hydroid: *Cuspidella* (?).

TOXORCHIS=*Toxorchis*+*Cladocanna*, Haeckel, 1879.
Four or more main radial-canals which branch dichotomously one or more times. Gonads on the outer branches of the canals near the ring-canal.

NETOCERTOIDES, Mayer, 1900.
Eight main radial-canals which branch dichotomously. Gonads extend outward from the sides of the stomach along the radial-canals.

### Family No. 2, EUCOPIDÆ.

Leptomedusæ with lithocysts, and with less than eight radial-canals upon which the gonads are developed.

### Subfamily No. 1, OBELINÆ.

With eight adradial lithocysts. Four radial-canals. Stomach without a peduncle.

EUCOPELLA, von Lendenfeld, 1883.
Degenerate medusæ. No tentacles. No manubrium. Branched radial-canals. Hydroid: *Eucopella*.

AGASTRA, Hartlaub, 1897.
Degenerate medusæ. No manubrium. Simple, unbranched radial-canals. Hydroid: *Campanularia* (?).

EUCOPE, Gegenbaur, 1856.
Basal bulbs of the tentacles are simple and hollow, and do not project inward into the gelatinous substance of bell. Lithocysts on bell-margin. Hydroid: *Campanularia*.

OBELIA, Péron and Lesueur, 1809.
Entodermal cores of tentacles project inward into the gelatinous substance of the bell. Otocysts on bases of tentacles. Hydroid: *Obelia*.

TIAROPSIS, L. Agassiz, 1849.
An ocellus with entodermal pigment above each lithocyst. Tentacle-bulbs simple and hollow.

### Subfamily No. 2, PHIALINÆ.

With more or less than eight lithocysts. Four to five radial-canals. Stomach without a peduncle.

CLYTIA, Lamouroux, 1812=*Epenthesis*, McCrady, 1857.
Sixteen tentacles alternating with sixteen lithocysts. Four radial-canals. No cirri. Hydroid: *Clytia*.

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PHIALIDIUM, Leuckart, 1856 = *Oceania*, Agassiz, 1862, 1865.
Sixteen or more tentacles. More than sixteen lithocysts. Four radial-canals. No rudimentary tentacles. No cirri. Hydroid: *Campanulina*.

PHIALUCIUM, Maas, 1905.
Similar to *Phialidium*, but with permanently rudimentary tentacle-bulbs. Hydroid unknown.

BLACKFORDIA, Mayer.
Numerous tentacles and lithocysts. Entodermal cores of some or all of the tentacles project inward into the gelatinous substance. Four radial-canals. No cirri. No permanently rudimentary tentacles.

PSEUDOCLYTIA, Mayer, 1900.
Five radial-canals, five lips, five gonads. Numerous tentacles and lithocysts. No cirri.

GASTROBLASTA, Keller, 1883 = *Multioralis*, Mayer, 1900.
Two or more manubria. No cirri. The medusa propagates by fission.

EUCHEILOTA, McCrady, 1857.
Four or more closed vesicular lithocysts. Four radial-canals. Marginal or lateral cirri. Hydroid: *Campanulina* (?).

MITROCOMA = *Phialis* + *Mitrocoma* + *Mitrocomium* + *Mitrocomella*, Haeckel, 1879.
Similar to *Eucheilota*, but the lithocysts are contained in open folds of the velum. No entodermal ocelli such as are found in *Tiaropsis*.

STAUROPHORA, Brandt, 1834 = *Staurostoma* + *Staurophora*, Haeckel, 1879.
Mouth an open, cruciform, gutter-like slit extending down the four radial-canals.

### Subfamily No. 3, EUTIMINÆ.

With eight adradial lithocysts. Stomach mounted upon a gelatinous peduncle. Four radial-canals.

SAPHENIA, Eschscholtz, 1829.
Two tentacles. Numerous cirri.

EUTIMA, McCrady, 1857 = *Eutima* + *Eutimeta* + *Octorchis* + *Octorchandra* + *Eutimalphes*, Haeckel, 1879.
Four or more tentacles. Numerous cirri or marginal warts. Four or eight gonads upon the four radial-canals. Hydroid: *Campanopsis* (Claus, Brooks).

EUTIMIUM = *Eutimium* + *Octorchidium*, Haeckel, 1879.
Similar to *Eutima*, but without cirri. Hydroid: *Campanulina* (?)

### Subfamily No. 4, EIRENINÆ.

With more than eight lithocysts. Stomach mounted upon a gelatinous peduncle. Four or six radial-canals.

PHORTIS, McCrady, 1857.
Four or more tentacles. No cirri. Four radial-canals. Hydroid: *Phortis* Brooks.

IRENOPSIS, Goette, 1886, *non Ireniopsis*, Mayer, 1894.
Six or more tentacles. Six radial-canals. Six lips. Six gonads.

EIRENE, Eschscholtz, 1829 = *Irene* + *Irenium*, Haeckel, 1879.
Four or more tentacles. Numerous marginal warts or cirri. Four or eight gonads developed upon limited parts only of the four radial-canals. Hydroid: *Campanulina* (?)

TIMA, Eschscholtz, 1829.
Similar to *Eirene*, but with gonads upon the *entire* lengths of the four radial-canals. Hydroid: *Campanulina* (?)

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### Family No. 3, ÆQUORIDÆ.

Leptomedusæ with otocysts, and with eight or more radial-canals.

OCTOCANNA, Haeckel, 1879.
Eight radial-canals, 45° apart. Eight lips. No ocelli. (Is this a young *Æquorea*?)

OCTOGONADE, Zoja, 1896.
Similar to *Octocanna*, but the marginal sense-organs have ocelli as well as lithocysts.

STOMOBRACHIUM, Brandt, 1835 = *Stomobrachium* + *Staurobrachium*, Haeckel, 1879.
Eight or more simple, unbranched radial-canals, which arise at equal intervals from the margin of the stomach. Four lips.

HALOPSIS, A. Agassiz, 1863, 1865.
Radial-canals arise in four groups from the four perradial corners of stomach. Four lips.

ÆQUOREA, Péron and Lesueur, 1809 = *Æquorea* + *Rhegmatodes* + *Mesonema* + *Polycanna*, Haeckel, 1879.
More than eight simple, unbranched radial-canals which arise separately from the margin of the stomach. More than four lips. Subumbrella smooth, without gelatinous papilla-like protuberances. Hydroid: *Campanulina*.

ZYGODACTYLA, Brandt, 1835; *sensu* Agassiz, 1862.
Similar to *Æquorea*, but with interradial rows of papilla-like, gelatinous protuberances upon the subumbrella.

ZYGOCANNA = *Zygocanna* + *Zygocannota*, Haeckel, 1879.
With bifurcated or branched radial-canals which arise at equal intervals from the margin of the stomach. More than four lips. No peduncle.

ZYGOCANNULA, Haeckel, 1879.
Similar to *Zygocanna*, but the stomach is mounted upon a gelatinous peduncle.

## Order No. 3. TRACHYMEDUSÆ Haeckel, 1866.

Medusæ with a marginal velum, and with lithocyst concretions of entodermal origin. With simple uncleft bell-margin.

### Family No. 1, OLINDIADÆ.

Some or all of the tentacles project from the sides of the bell, above the margin, and have adhesive disks. Gonads linear, sac-like, or folded, and developed upon the four or six radial-canals. The tentacles arise separately and are not grouped in clusters.

GONIONEMUS, A. Agassiz, 1862, 1865.
All of the tentacles project from sides of bell in a zone slightly *above* bell-margin. All have adhesive disks. Four radial-canals. Lithocysts external, on bell-margin. No centripetal canals. Development through an attached hydra stage. (Perkins.)

CUBAIA, Mayer, 1894.
Similar to *Gonionemus*, but with two sets of tentacles, one arising from the bell-margin and the other set projecting from the sides of the bell, as in *Gonionemus*.

VALLENTINIA, Browne, 1902.
Similar to *Cubaia*, but with lithocysts inclosed within the gelatinous substance of the bell, adjacent to the ring-canal, and on the inner side above the velum. (Is this a young *Olindias*?)

OLINDIAS, F. Müller, 1861.
Similar to *Vallentinia*, but with blindly-ending, centripetal diverticula from the ring-canal.

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OLINDIOIDES, Goto, 1903.
Similar to *Olindias*, but with six radial-canals (two bifurcated and two simple). Six gonads. Four lips. The exumbrella tentacles project at various levels from the sides of the bell.

**Family No. 2, PETASIDÆ Haeckel, 1879.**

Trachymedusæ with four radial-canals upon which the linear or sac-like gonads are developed. Tentacles without adhesive disks. Four lips.

PETASUS = *Petasus* + *Dipetasus* + *Petasata* + *Petachnum*, Haeckel, 1879.
Tentacles arise at equal intervals, not grouped into clusters. No centripetal canals. Free marginal lithocyst-clubs.

AGLAUROPSIS, F. Müller, 1865.
Similar to *Petasus*, but the lithocysts are vesicular, and project from the bell-margin between the tentacles.

CRASPEDACUSTA, Lankester, 1880 = *Limnocodium*, Allman, 1880.
Tentacles arise singly as in *Petasus* and *Aglauropsis*, but the lithocyst concretions are each inclosed in a cavity within the gelatinous substance of the velum on the inner (centripetal) side of the ring-canal. (The medusa lives in fresh water among water-lilies.) The hydroid is devoid of tentacles.

MICROHYDRA, Potts, 1885.
Is possibly identical with *Limnocodium*, but the mature medusa is unknown. The young medusa has no lithocysts, and it arises by budding from a minute hydroid which has no tentacles.

MÆOTIAS, Ostroumoff, 1896.
Tentacles arise at equal intervals, not in clusters. Numerous centripetal, blindly-ending canals arise from the ring-canal.

GOSSEA, L. Agassiz, 1862.
Tentacles grouped into clusters. No centripetal canals. Lithocyst concretions free or inclosed.

**Family No. 3, LIMNOCNIDIDÆ.**

Numerous hollow tentacles which project singly, not in clusters, from the sides of the bell in a zone slightly above the margin. Tentacles without adhesive disks. Numerous inclosed lithocysts on the exumbrella side of the velum. Mouth a round opening. Gonads developed diffusely in the ectoderm of the stomach-wall. Four (occasionally five or six) radial-canals. Medusa-buds arise from the sides of the stomach, and are set free.

LIMNOCNIDA, Günther, 1893.
Generic characters are those of the family. The only known species is *L. tanganjicæ* from the fresh-water lakes of Central Africa, and the Niger river.

**Family No. 4, PTYCHOGASTRIDÆ.**

Numerous more or less isolated clusters of tentacles, some of which bear adhesive disks. Numerous free lithocyst-clubs. Eight radial-canals. Four lips. Stomach eight-lobed. These stomach-lobes are in the radii of the radial-canals, and are bound to the subumbrella by means of eight mesenterial partitions. The gonads are upon the eight stomach-lobes, and each is more or less divided by the mesentery so there may be eight double (sixteen) gonads.

PTYCHOGASTRIA, Allman, 1878 = *Pectyllis* + *Pectis* + *Pectanthis*, Haeckel, 1879.
The generic characters are those of the family.

**Family No. 5, TRACHYNEMIDÆ.**

Trachymedusæ with eight simple radial-canals upon which the gonads are developed. No mesenterial partitions in the subumbrella. Tentacles without adhesive disks. Ring-canal simple without centripetal branches.

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**Subfamily No. 1, RHOPALONEMINÆ.**

Trachynemidæ in which the stomach lacks a peduncle.

RHOPALONEMA, Gegenbaur, 1856=*Trachynema* (young medusa), Gegenbaur, 1854
=*Trachynema*+*Rhopalonema*+*Marmanema*, Haeckel, 1879.

With eight well-developed radial tentacles, and eight or more small cirrus-like or club-shaped interradial tentacles. All tentacles arise in a single row. Eight gonads localized on the eight radial-canals. Four lips.

SMINTHEA, Gegenbaur, 1856.

Similar to *Rhopalonema*, but with only eight tentacles, one at the foot of each of the eight radial-canals.

HOMŒONEMA, Maas, 1893=*Colobonema*, Vanhöffen, 1902=*Isonema* (in part), Maas, 1906.

Similar to *Rhopalonema*, but the tentacles are all of one sort. No small club-shaped or cirrus-like tentacles. Four lips.

PANTACHOGON, Maas, 1893 (*sens. ampl.*).

Gonads not localized as in *Homœonema* and *Rhopalonema*, but developed diffusely over the radial-canals. Four lips.

HALICREAS, Fewkes, 1882=*Halicreas*+*Haliscera*, Vanhöffen, 1902
=*Isonema* (in part), Maas, 1906.

The mouth is a simple round opening, without four lips. (In all known species the radial-canals and ring-canals are very broad and flat.) Wart-like protuberances may be present upon the sides of the exumbrella. Radial tentacles large, interradial, small. Tentacles arise in a single row.

BOTRYNEMA, Browne, 1908.

Similar to *Halicreas*, but the tentacles are grouped in linear clusters in a single row around the bell-margin.

CROSSOTA, Vanhöffen, 1902.

The tentacles arise in several rows from the bell-margin. Mouth with four lips.

**Subfamily No. 2, AGLAURINÆ.**

Stomach mounted upon a peduncle.

AGLAURA, Péron and Lesueur, 1809.

Eight gonads upon the peduncle above the stomach. Sexes separate. Development direct.

AGLANTHA=*Aglantha*+*Agliscra*, Haeckel, 1879.

Eight gonads upon the subumbrella, or at the turning points of the eight radial-canals between the peduncle and the subumbrella. Sexes separate.

AMPHOGONA, Browne, 1904.

Similar to *Aglantha*, but medusa is bisexual, four of gonads being male, and four female.

STAURAGLAURA, Haeckel, 1879.

Four gonads, one upon each alternate radial-canal.

PERSA, McCrady, 1857.

Two gonads on two of the radial-canals, 180° apart. The six other radial-canals are sterile.

**Family No. 6, GERYONIDÆ.**

Trachymedusæ with four or six radial-canals upon which the flat, expanded, leaf-like gonads are developed. Stomach mounted upon a gelatinous peduncle. The ring-canal gives rise to blindly-ending centripetal canals.

LIRIOPE, Lesson, 1843=*Liriantha*+*Liriope*+*Glossocodon*+*Glossoconus*, Haeckel, 1879.

Four radial-canals. Four gonads. Four lips. With four primitive, solid, radial, and four solid interradial, and four hollow, flexible, radially-placed tentacles; all twelve of which may be found upon the medusa at one and the same time. Development direct through a free-floating, actinula-like larva.

GERYONIA, Péron and Lesueur, 1809=*Geryones*+*Geryonia*+*Carmaris*
+*Carmarina*, Haeckel, 1879.

Similar to *Liriope*, but with six radial-canals, six gonads, six lips, etc.; instead of four.

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## Order No. 4. NARCOMEDUSÆ Haeckel, 1879.

Veiled medusæ with bell-margin cleft into intertentacular lappets. With free lithocyst-clubs, containing concretions of entodermal origin. These medusæ develop from actinula larvæ either directly or by budding. The bell grows outward from the sides of the body of the actinula, or the medusa-bud, leaving the tentacles stranded in the partially closed-over clefts between the lappets of the bell. The Narcomedusæ are thus medusiform, actinula-like animals, the bell of which is not homologous with that of the Anthomedusæ or Leptomedusæ.

### Family No. 1, SOLMARIDÆ.

Narcomedusæ in which the outer margin of the stomach is plain, entire, and without peripheral stomach-pouches. Saccules may, however, arise from the subumbrella floor of the stomach.

SOLMARIS = *Polycolpa* (young) + *Solmaris*, Haeckel, 1879.
Without subumbrella saccules. Gonad is a simple annulus in ectoderm of subumbrella floor of stomach.

PEGANTHA = *Pegasia* + *Polyxenia* + *Pegantha* + *Solmoneta* (in part), Haeckel, 1879.
With out-pocketings on the subumbrella floor of the stomach. The gonads are developed in these subumbrella saccules.

### Family No. 2, ÆGINIDÆ, sens. ampl.

Narcomedusæ in which the central stomach gives rise to simple or cleft marginal out-pocketings in the radii of the tentacles.

CUNANTHA, Haeckel, 1879.
Four tentacles. Four peronial strands in the tentacular radii. Four simple, uncleft, peripheral stomach-pouches in the radii of the tentacles. This "genus" is probably only a young stage of *Ægina*.

ÆGINA, Eschscholtz, 1829 = *Cunarcha* + *Ægina* + *Solmundus*, Haeckel, 1879.
Four tentacles. Four peronial strands. Four cleft (= eight peripheral) stomach-pouches, outer margins of which may be still further divided.

SOLMUNDELLA = *Æginella* + *Solmundella*, Haeckel, 1879.
Two tentacles. Four peronial strands. Four cleft (= eight peripheral) stomach-pouches. An apical (exumbrella) sense-organ is present in larva, but does not persist in adult. Derived from *Ægina* by the disappearance of half of its tentacles.

HYDROCTENA, Dawydoff, 1903.
Two tentacles. No peronial strands. Two simple, uncleft stomach-pouches in the tentacular radii. There is an apical (exumbrella) sense-organ consisting in a ciliated pit containing two lithocyst-clubs. A median axial canal extends upward from the stomach to the bottom of the sensory pit.

CUNOCTANTHA, Haeckel, 1879.
Eight tentacles. Eight peronial strands. Eight simple, uncleft stomach-pouches in the tentacular radii.

ÆGINURA = *Cunoctona* + *Æginura*, Haeckel, 1879.
Eight tentacles. Eight peronial strands. Eight cleft (= sixteen peripheral) stomach-pouches. The outer margins of these pouches may be still further divided so as to give thirty-two marginal pouches.

ÆGINOPSIS, Brandt, 1835.
Four tentacles. Eight peronial strands. Eight cleft (= sixteen peripheral) stomach-pouches. Derived from *Æginura* by the disappearance of half of its tentacles.

CUNINA, Eschscholtz, 1829.
Nine or more tentacles, and an equal number of peronial strands. Peripheral stomach-pouches simple, uncleft and equal in number to the tentacles, in the radii of which they are developed. With otoporpæ above the sense-clubs.

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SOLMISSUS, Haeckel, 1879.
Similar to *Cunina*, but without otoporpæ.

CUNISSA = *Cunissa* + *Æginodorus*, Haeckel, 1879.
Nine or more tentacles, and the same number of peronial strands. Peripheral stomach-lobes twice as numerous as the tentacles, being cleft in the tentacular radii.

ÆGINODISCUS, Haeckel, 1879.
Eight tentacles, sixteen peronial strands. Sixteen cleft (=thirty-two peripheral) stomach-pouches.

## MEDUSÆ MILLEPORINÆ.

Under this heading we may place the degenerate, free-swimming medusæ of Millepora. They have no velum and are thus separated from the veiled medusæ or Craspedotæ. Not only is the velum absent, but the medusa is also devoid of a peripheral canal system and of marginal tentacles.

The medusæ Milleporinæ and Craspedotæ are doubtless derived from a common ancestral phylum, but have departed widely, one from the other, so that the Craspedotæ are constantly characterized by a diaphragm-like membrane, or velum, which partially closes the opening of the bell-cavity at the tentacular margin; whereas this structure is absent in the Milleporinæ.

The only known forms of Medusæ Milleporinæ are those of Millepora.

### Millepora alcicornis (Medusa).

*Millepora* (medusæ), HICKSON, 1900, Proc. Roy. Soc. London, vol. 66, p. 3, figs. 1-10.—DUERDEN, 1899, Journal of the Institute of Jamaica, March, 1899.—HICKSON, 1906, Cambridge Natural History, vol. 1, Cœlenterata, p. 259, fig. 129.

Each medusa lies in an ampulla, or cavity, of the corallum, and is attached by a narrow stalk to the innermost part of the wall of the cavity. The bell is 0.4 to 0.6 mm. in diameter and is devoid of radial or circular canals or velum. It consists of a median lamella of entoderm covered on the exumbrella and subumbrella sides by an ectodermal epithelium. There are no tentacles, but instead there are 4 or 5 swollen masses of nematocysts 90° or 72° apart, near the bell-margin, but projecting from the sides of the exumbrella. The manubrium is greatly swollen, and fills the greater part of the bell-cavity. A mouth may (or may not?) be present. There are 1 to 5, usually 3 or 4, large ova in the ectoderm (?) of the manubrium. The central entodermal cavity of the manubrium consists of an axial chamber which often gives rise to 4 perradial pouches which project into the entoderm of the manubrium, and end blindly. In some medusæ these pouches do not exist, in other specimens there are but 2 or 3, but probably the most common condition is that of 4 pouches 90° apart. The fully-developed ova occupy positions alternating with the pouches. Dr. Duerden observed that these medusæ are set free and swim slowly about with infrequent feeble pulsations. Soon after liberation the ova begin to be discharged into the water and the medusa dies after 5 or 6 hours of life, having discharged all of its eggs.

The Pacific millepores also produce medusæ (see Hickson, S. J., 1891, Quart. Journ. Micros. Sci., 1898; Proc. Zool. Soc. London; and Philosoph. Trans. Roy. Soc. London, B, vol. 179).

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# VEILED MEDUSÆ.

## MEDUSÆ CRASPEDOTÆ Gegenbaur, 1856.

*Cryptocarpæ*, Eschscholtz, 1829, Syst. der Acalephæ.
*Gymnopthalmæ*, Forbes, 1848, British Naked-eyed Medusæ.
*Craspedota*, Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, p. 217.
*Craspedotæ*, Haeckel, 1879, Syst. der Medusen.—Maas, 1893, Ergeb. der Plankton-Expedition, Bd. 2, K. c.

### CHARACTERS OF THE VEILED MEDUSÆ.

Medusæ with a velum or diaphragm which partially closes the marginal opening of the bell-cavity; with ectodermal gonads (i. e., the sexual products *when ripe* are commonly found in the ectoderm). Without gastric filaments. With a double marginal nerve-ring, one above and one below the velum. Development either direct or through alternation of generations from hydroids.

## Order ANTHOMEDUSÆ Haeckel, 1879.

*Oceanida* (in part), Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, pp. 218, 219.
*Tubularia* (in part), Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 337.
*Anthomedusæ*, Haeckel, 1879, System der Medusen, p. 3.—Vanhöffen, 1891, Zoologischer Anzeiger, Bd. 14, pp. 439, 442.—Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, p. 5; 1897, Mem. M. C. Z. at Harvard Coll., vol. 23, p. 9.—Hartlaub, 1892, Nachrichten kgl. Gesell. Wissenschaften Göttingen, p. 17; 1897, Nordisches Plankton, Nr. 12, p. 4.—Hargitt, 1905, Bull. U. S. Bureau of Fisheries, vol. 24, p. 29.

### CHARACTERS OF THE ANTHOMEDUSÆ.

Hydromedusæ in which the gonads are contained within the ectoderm of the manubrium. There are no marginal otocysts or sensory clubs. The hydroids are of the Tubularian order.

We may distinguish three families:

(1) *Codonidæ* with simple tentacles, and with the gonad in the form of one or more rings encircling the manubrium. No oral tentacles.

(2) *Cladonemidæ* with feathered or branched marginal tentacles. Gonads ring-like, or more or less separated. With or without oral tentacles.

(3) *Oceanidæ* with gonads confined to the interradial or adradial sides of the manubrium and separated one from another in the meridians of the principal radii. With or without oral tentacles. With unbranched marginal tentacles.

The bell in the Anthomedusæ is without marginal lappets, and usually dome-shaped. The tentacles arise from the bell-margin, not from the sides of the bell. The velum is simple and annular, and is provided with circular muscles serving to produce the periodic contractions of the bell. The bell-margin is simple and entire, and there are no otocysts, otolith-clubs, or club-shaped sense-organs. Marginal cirri rarely present. In the young medusa the exumbrella is more or less besprinkled with nematocysts, but these usually disappear or become less conspicuous in the adult; although definite nematocyst tracts often persist over the exumbrella, this being far more commonly seen in Anthomedusæ than in other orders of Hydromedusæ.

The tentacles usually arise singly from the bell-margin, and are usually simple and unbranched. Ectodermal ocelli are often found upon the tentacle-bulbs, and Romanes showed that in *Sarsia* these subserved a visual function, and that the medusa was strongly attracted by rays between the red and violet. The main shafts of the tentacles are thickly covered with nematocysts, which may be mounted upon filaments or converted into adhesive organs, as in the Cladonemidæ. The tentacle-bulbs are hollow, and connected with the gastrovascular system of the medusa.

The radial-canals are usually simple, but in the Tiarinæ they often give rise to short, blindly-ending diverticula, which may be glandular in function. Glandular swellings are found in the walls of the radial-canals of *Lymnorea alexandri*, and probably in those of *Dysmorphosa dubia* and *Slabberia halterata*. A ring-canal is present in all genera excepting



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*Pachycordyle* and the Williadi, where it has become filled with a more or less solid core of entoderm cells. The ring-canal is usually simple, and rarely gives rise to blindly-ending diverticula.

The proboscis, or manubrium, is usually flask-shaped, and the mouth in most of the Codonidæ is a simple round, or cruciform, opening, but in the Oceanidæ it is surrounded by lips which are more or less folded or crenated. Oral tentacles are found in the Margelinæ, and in some Cladonemidæ. The stomach is often mounted upon a solid, conical peduncle, but in *Turritopsis* the peduncle is made up of large, highly-vacuolated, entodermal cells which constitute the walls of the proximal parts of the 4 radial-canals. The medusæ are carnivorous, feeding upon crustacea, fishes, and other medusæ or Siphonophoræ.

In the Codonidæ the gonad encircles the manubrium in a ring-like manner, the mature genital products being found in the ectoderm on the sides of the stomach. In the genus *Slabberia* there are 2 or more of these genital rings. In the Oceanidæ, however, the gonads are restricted to the interradial, or adradial, sides of the stomach. Haeckel, 1879, believed that they were radial in position, corresponding with the radial-canals, but Vanhöffen, 1891, showed that this was an error, for they are commonly interradial, or on both sides of each radial line. In *Eleutheria*, according to Hartlaub, and possibly in other Cladonemidæ, the genital products are developed in the ectoderm of a peculiar brood-pouch, which is not connected with the stomach, but is invaginated from the general ectodermal wall of the subumbrella. In the Williadi and in *Nemopsis* the radial corners of the stomach extend outward along the radial-canals, and the gonads develop upon the sides of these pouches. *Eleutheria* is successively hermaphroditic, either sex preceding, but in all other Anthomedusæ the sexes are separate. The mature genital products are usually found in the ectoderm, although they often originate in the entoderm. The eggs are cast out into the water by the breaking down of the ectodermal walls of the manubrium, but in some species of *Bougainvillia*, or in *Margelopsis*, or *Hybocodon*, the larvæ may be retained until they have passed into the planula or even into the actinula stage. None of the Anthomedusæ are known to develop directly from the egg into medusæ, but the hydroid stages of many genera remain unknown. Wherever the sexual development is known it is through hydroids of the Tubularian order, in which the medusæ bud out separately and are not protected in special capsules or sporangia.

Asexual development of medusæ is found in Codonidæ, in medusæ of the genera *Hybocodon*, *Slabberia*, and *Sarsia*, and in the Oceanidæ in the genera *Cytæis*, *Dysmorphosa*, *Bougainvillia*, *Rathkea*, and in the Williadi. In some of the Williadi the medusa-buds are borne upon stolons which arise either from the radial corners of the stomach, or from the forks of the radial-canals. In the case of *Sarsia* and *Hybocodon* the budding medusæ develop as in hydroids, the entoderm of the parent medusa forming the entoderm of the budded medusa, and the ectoderm of the bud being formed from the ectoderm of the parent. In *Rathkea*, Chun, 1895, discovered that the budding medusa is formed out of the ectoderm of the parent, although a connection is finally established between the entoderm of the bud and that of the parent a short time before the bud is set free. In *Bougainvillia niobe*, on the other hand, I find that the budding medusa is formed entirely from the ectoderm of the parent, no connection being established between the entoderm of the bud and that of the parent. In the genus *Niobia* the tentacle-bulbs develop into medusæ and are set free.

The majority of the Anthomedusæ undergo a considerable development while swimming freely in the water. In some cases, however, the medusæ may, at times, become mature and even discharge their genital products while still attached to the hydroid. This is seen in *Pennaria*, *Podocoryne*, *Sarsia*, and *Stylactis*. Among the most short-lived medusæ are those of *Pachycordyle*, which have neither tentacles, marginal sense-organs, nor radial nor circular canals.

All of the Anthomedusæ are inhabitants of salt water. They are rare in the open ocean far from land, but are abundant along coasts, especially along continental shores, and many of them thrive in harbors where the water may be more or less brackish. They appear to be the simplest, and phylogenetically the oldest, of the Hydromedusæ.

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## Family CODONIDÆ Haeckel, 1879, sens. amend.

*Sarsiadæ* (in part), FORBES, 1848, British Naked-eyed Medusæ, p. 55.
*Sarsiadæ+Tubularidæ*, McCRADY, 1857, Gymn. Charleston Harbor, p. 21.
*Sarsiadæ* (in part)+*Tubularidæ*+*Pennaridæ* (in part), AGASSIZ, L., 1862, Cont. Nat. Hist. U. S., vol. 4, pp. 339, 342.
*Sarsiadæ+Orthocorynidæ+Tubularidæ+Pennaridæ*, AGASSIZ, A., 1865, North Amer. Acalephæ, pp. 175, 183, 186, 189.
*Codonidæ*, HAECKEL, 1879, Syst. der Medusen, p. 9.—VANHÖFFEN, 1891, Zool. Anzeiger, Bd. 14, p. 442.—HARGITT, 1904, Bull. Bureau of Fisheries U. S., vol. 24, p. 29.—HARTLAUB, 1907, Nordisches Plankton, Nr. 12, pp. 5, 6.
*Codoninæ+Corynidæ+Tubularidæ*, VON LENDENFELD, 1884, Zool. Anzeiger, Bd. 7, pp. 446, 447.

### FAMILY CHARACTERS.

Anthomedusæ in which the gonad is ring-like and encircles the manubrium. Mouth without oral tentacles or prominent lips. The 4 to 6 radial-canals are simple and unbranched. When ocelli are present they are found upon the outer sides of the tentacle bulbs. There are no marginal otocysts. The tentacles are neither branched nor feathered.

Medusæ of the genera *Sarsia*, *Steenstrupia*, *Ectopleura*, *Pennaria*, *Amalthæa*, *Trichorhiza*, *Hybocodon*, *Hydrichthys*, *Corynitis*, and *Margelopsis* are known to develop asexually through alternation of generations from Tubularian hydroids. Direct development of medusæ from the egg is unknown in this family, although medusæ are budded asexually from the manubrium of some species of *Sarsia*, from the basal bulbs of the tentacles of *Hybocodon*, and from those of *Sarsia*. Actinula larvæ are set free from the manubrium of *Margelopsis* and *Hybocodon*.

Haeckel, 1879, considered the presence or absence of an apical projection upon the bell, and the presence or absence of an axial canal extending upward from the stomach into this apex, to be a criterion for the separation of genera. It should be borne in mind, however, as was pointed out by Vanhöffen, 1891 (Zool. Anzeiger, pp. 439–446), that the young medusæ often lack an apical projection and axial canal, whereas the mature individuals possess these characters. They are also highly variable in development. We have therefore considered these characters to be of specific but not generic value.

A natural classification of the Codonidæ can not be based upon the characters of the medusæ alone, for the medusæ of *Pennaria* and *Amalthæa* are similar, while their hydroids are distinct, the former being *Pennaria* and the latter *Corymorpha*, and an equally remarkable condition is presented by hydroids belonging to the two genera *Syncoryne* and *Stauridia*, both of which give rise to medusæ belonging to the genus *Sarsia*. This peculiar case is still further complicated by the fact that at least one species of *Stauridia* hydroid gives rise to a *Cladonema* medusa.

In *Hydrichthys* we meet with an extraordinary case of parasitism or commensalism of the hydroid, and in *Margelopsis* we find a free-floating hydranth, recalling the hypothetical ancestral form of the Siphonophoræ. *Margelopsis* is also interesting in that its medusæ form, apparently, a connecting link between the Codonidæ and the Bougainvilleæ, although they are more closely related to the Codonidæ than to the last-named family. Indeed their resemblances to the Bougainvilleæ are probably due to mere parallelism and not to blood-relationship.

The Codonidæ may conveniently be divided into two subfamilies, as follows:

(1) *Sarsianæ*, with simple, unbranched, marginal tentacles, which arise singly from the bell-margin. One or all of the tentacles may be degenerate or absent.
(2) *Margelopsinæ*, with marginal tentacles grouped into clusters.

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The following table defines the characters of the genera of Codonidæ.

## Subfamily No. 1. Sarsianæ.

With simple marginal tentacles which arise singly from bell-margin. One or all of the tentacles may be rudimentary or absent.

Tribe I. Anemidi.
Without tentacles or chymiferous canals.
*Pachycordyle*, Weismann, 1883; Hargitt, 1904=*Parvanemus* (?) Mayer, 1904.
Medusa without tentacles, marginal sense-organs, radial-canals or circular canal. Hydroid: *Pachycordyle*, Weismann.

Tribe II. Amalthiadi.
The hydroid is *Corymorpha*. Medusæ have 4 radially placed, rudimentary tentacles and 4 radial-canals.
*Amalthæa*, Schmidt, 1854. Medusa=*Amalthæa*, Haeckel.
With 4 rudimentary tentacles, 4 radial-canals, and ring-canal. Genital products on manubrium. Hydroid: *Corymorpha*.

Tribe III. Pennaridi.
Medusæ similar to those of Tribe II, but hydroid is *Pennaria*.
*Pennaria*, Oken, 1815; Goldfuss, 1820.
With 4 rudimentary tentacles, 4 radial-canals, and ring-canal. Genital products within manubrium. Hydroid: *Pennaria*.

Tribe IV. Pseudopennaridi.
Medusa similar to those of Tribes II and III, but hydroid is *Trichorhiza*.
*Trichorhiza*, Russell, 1906.
Medusa similar to *Pennaria*, but hydroid is *Trichorhiza*.

Tribe V. Euphysidi.
With small or rudimentary tentacles situated at bases of all but one radial-canal, and with one or more well-developed tentacles situated at base of remaining radial-canal. Bell may or may not possess an apical projection, or an axial canal extending into it from stomach-cavity.
*Steenstrupia*, Forbes, 1846=*Euphysa*, Forbes, 1848; *Euphysora*, Maas, 1905.
The bell is radially symmetrical and the 4 radial-canals are all of equal length. 1 long and 3 short tentacles. Hydroid: *Corymorpha*.
*Hybocodon*, L. Agassiz, 1862=*Amphicodon*, Haeckel, 1879.
The bell is asymmetrical. One of the 4 radial-canals is long, the one opposed to it short, and the two other canals of intermediate length. One long tentacle arises from the base of the long radial-canal, while the other 3 tentacles are short In old medusæ of *Hybocodon* one is apt to find 2 or more tentacles at the base of the long radial-canal, and the medusa is in the *Amphicodon* stage. Hydroid: *Hybocodon*.
*Microcampana*, Fewkes, 1889.
With 6 radial-canals and 6 tentacles, one of which is well-developed and 5 are rudimentary. Hydroid unknown.

Tribe VI. Dicodonidi.
With 2 well-developed, diametrically opposite tentacles, and 2 rudimentary tentacles. With or without an apical projection and with or without axial canal extending upward from the stomach into apex of bell.
*Dicodonium*, Haeckel, 1879.
With 4 simple radial-canals and 4 radially placed tentacles; 2 of the tentacles are long, and 2 short. Gonad is ring-like and surrounds stomach. No lines of nettling cells over exumbrella.

Tribe VII. Sarsiadi.
Bell radially symmetrical. With 4 equally-developed, unbranched, marginal tentacles. With or without an apical projection, and with or without an axial canal extending upward from stomach into apex of bell. (1) The manubrium is encircled by a single ring-like gonad. (2) With 2 or more ring-like gonads upon the manubrium.
*Sarsia*, Lesson, 1843=*Syndictyon*, A. Agassiz, 1862; *Codonium*, Haeckel, 1879.
Manubrium slender and tubular. Each tentacle-bulb bears an abaxial, ectodermal ocellus. Hydroid: *Syncoryne*. Also *Stauridia*.
*Hydrichthys*, Fewkes, 1888.
Medusa similar to *Sarsia*, but without ocelli upon the tentacle-bulbs. Hydroid: *Hydrichthys*.
*Encodonium*, Hartlaub, 1907.
Medusa similar to *Sarsia*, but stomach is mounted upon a gelatinous peduncle, and tentacles end each in a knob.
*Ectopleura*, L. Agassiz, 1862.
8 longitudinal lines of nematocysts extend from bases of tentacles to apex of bell. Hydroid: *Ectopleura*.
*Corynitis*, McCrady, 1857.
Manubrium cruciform in cross-section, and bound to the 4 radial-canals by hollow mesenteries. 4 radially placed marginal tentacles which are covered with wart-like clusters of nematocysts. Their basal bulbs bear ocelli. Hydroid: *Syncoryne*.
*Slabberia*, Forbes, 1846=*Dipurena*, McCrady, 1857. *Dipurena*+*Bathycodon*, Haeckel.
Similar to *Sarsia*, but with two or more ring-like gonads upon the manubrium. Hydroid: *Syncoryne*.

## Subfamily No. 2. Margelopsinæ.

With 4 radially-placed clusters of marginal tentacles. No oral tentacles. Gonads ring-like, and encircling the manubrium.
*Margelopsis*, Hartlaub, 1897.
Marginal tentacles are grouped in 4 radially-situated clusters. Gonad ring-like, and surrounds manubrium. No oral tentacles, mouth is a simple round opening. Medusæ develop by budding from a free-floating hydranth, *Margelopsis*. This interesting genus recalls the *Bougainvillidi* in its radially situated clusters of marginal tentacles. It resembles the *Codonidæ* in its ring-like gonad, and in the absence of prominent lips and oral tentacles.
*Pelagohydra*, Dendy, 1903.
Medusa similar to *Margelopsis* but hydroid is *Pelagohydra*, and differs from hydroid of *Margelopsis* in that tentacles arise at irregular intervals from the sides of the hydranth and are not arranged in definite verticils as in *Margelopsis*. Hydroid is pelagic.

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## Plate 1.

Fig. 1. *Pachycordyle degeneratus*, male. Nassau Harbor, Bahama Islands, July 19, 1903.

Fig. 2. Budding hydranth of *Pennaria tiarella* with female medusa-bud still attached. Agassiz Laboratory, Newport, Rhode Island, July 5, 1895. Found attached to eel grass in shallow water.

Fig. 3. A recently liberated male medusa of *Pennaria tiarella*. Agassiz Laboratory, Newport, Rhode Island, July, 1895.

Fig. 4. Hydroid stock of *Pennaria tiarella*, natural size. Agassiz Laboratory, Newport, Rhode Island, July, 1895.

Fig. 5. *Pennaria tiarella*. From the coral reef at Tortugas, Florida, May 7, 1905.

Fig. 6. *Steenstrupia virgulata*. From a drawing made from life by Dr. Alexander Agassiz at Nahant, Massachusetts, August 21, 1862.

Fig. 7. *Steenstrupia rubra*, male. Oregon Inlet, Pamlico Sound, North Carolina, November 12, 1904.

Fig. 8. *Hybocodon forbesii*. Tortugas, Florida, May 25, 1905.

Fig. 6, from a drawing by Dr. Alexander Agassiz.
Figs. 1 to 5, 7, 8, from life, by the author.

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## DESCRIPTION OF GENERA AND SPECIES OF ANTHOMEDUSÆ.

### Genus PACHYCORDYLE Weismann, 1883.

*Pachycordyle*, WEISMANN, 1883, Entstehung Sexualzellen Hydromedusen, pp. 87, 217. -HARGITT, 1904, Mitth. Zool. Station Neapel, Bd. 16, p. 553.
*Parvanemus*, MAYER, 1904, Mem. Nat. Sci. Museum Brooklyn Institute Arts and Sci., vol. 1, No. 1, p. 6.

#### GENERIC CHARACTERS.

Codonidæ without tentacles, radial-canals, or circular vessel. Manubrium surrounded by a ring-like gonad. The hydroid-stock is *Pachycordyle*.

Except the medusæ of Millepora, these are the most degenerate and short-lived of the free-swimming Hydromedusæ. They are even more degenerate than are the medusæ of *Corymorpha* and *Pennaria*, and may be compared with *Eucopella* (R. von Lendenfeld, 1883, Zeit. für wissen. Zool., Bd. 38, p. 497) and *Agastra* (C. Hartlaub, 1897, Wissen. Meeresuntersuch. Biologisch. Anstalt auf Helgoland, Neue Folge, Bd. 2, Heft 1, Abt. 2, p. 504, taf. 22, figs. 5, 8–10). In these last-named medusæ we find neither manubrium nor marginal tentacles, but there are 8 otocysts and a velum, and the radial and circular vessels are well developed.

#### Pachycordyle weismanni Hargitt.

*Pachycordyle weismanni*, HARGITT, 1904, Mitth. Zool. Station Neapel, Bd. 16, Heft 4, p. 553, plate 21, figs. 1-8.
(?) *Pachycordyle napolitana*, WEISMANN, 1883, Die Entstehung der Sexualzellen bei den Hydromedusen, Jena, pp. 87, 217.

Medusa pyriform, 2 mm. high, 1.3 mm. wide. Tentacles and marginal sense-organs lacking. No radial-canals. Ring-canal a mere fissure with vestiges of an entodermal lining near the margin. Velum narrow, with a small opening. Manubrium large, conical, and without a peduncle. Ripe ova are in the entoderm, and are discharged very soon after medusa is liberated. Mouth lacking. Manubrium orange or dark-brown, other parts colorless. The medusa swims with a short, jerky motion, but lives only one or two hours.

The hydroid is found in the Bay of Naples growing upon the shell of *Fusus rostratus*. The colony arises from a delicate, reticulated hydrorhiza. Hydrocaulus sparingly branched, 3 to 8 mm. high. Perisarc dull yellowish-brown, not extending beyond base of the hydranth. Hydranths club-shaped, with subconical hypostome. 8 to 16 irregularly arranged filiform tentacles, delicate and thread-like when expanded. Body of hydranth orange or reddish, hypostome whitish. Not more than 2 or 3 medusa-buds are borne on the side of the stem of each budding polyp. Occasionally the medusa-buds develop on the side branches, more commonly on the main stems. The ova originate in the entoderm where they remain until discharged into the water from the manubrium of the medusa. This species may possibly be the female form of Weismann's *Pachycordyle napolitana*. On Weismann's hydroid, however, there were no free medusæ, only sessile gonophores. All of Weismann's specimens were males, while Hargitt's were females, and it is possible, as Hargitt states, that the females only give rise to free-swimming medusæ.

#### Pachycordyle degeneratus.

Plate 1, fig. 1.

*Parvanemus degeneratus*, MAYER, 1904, Memoirs Nat. Sci. Museum Brooklyn Institute of Arts and Sci., vol. 1, No. 1, p. 6, plate 3, fig. 22.

Bell thin-walled, about 0.75 mm. high and 0.3 mm. in diameter. Bell-walls quite rigid, velum powerful and well developed. There are neither tentacles, radial-canals, circular vessel, nor marginal sense-organs. Manubrium spindle-shaped, and about a third as long as height of bell. Fluids within the stomach-cavity are maintained in rapid motion, apparently through the action of cilia. Near aboral end of bell is a deep conical cicatrice which apparently marks the place of last connection between the medusa and its hydroid stock. Bell is translucent and milky in color, while manubrium is cream-colored. Only 5 specimens, all males, were found in Nassau Harbor, Bahamas, on the nights of July 18 and 19, 1903.

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They swam actively in arcs of circles, but all died early in the morning although maintained in large glass dishes filled with pure sea-water. They appeared to be mature, for sperm was discharged constantly from the sides of the manubrium.

The hydroid is unknown, and possibly the medusa may not belong to the genus *Pachycordyle*, though in the medusa stage it conforms with the generic character of the medusæ which are set free from *Pachycordyle weismanni* of Naples.

### Genus AMALTHÆA Schmidt, 1854.

*Corymorpha* (hydroid), SARS, M., 1835, Beskriv og Jagttagelser, p. 7.
*Corymorpha* (medusa and hydroid), STEENSTRUP, 1854, Vidensk. Meddel. Nat. For. Kjöbenhavn, p. 46.
*Amalthæa* (medusa), SCHMIDT, 1854, Handatlas vergl. Anatomie, p. 13.—HAECKEL, 1879, Syst. der Medusen, p. 38.
*Amalthæa*, ALLMAN, 1872, Monog. Tubularian Hydroids, p. 393.—LOMAN, 1889, Tijdschrift, Nederland. Dierk. Vereen, Ser. 2, Deel. 2, p. 270.
*Corymorpha*, HARTLAUB, 1905, Zoolog. Jahrb., Abth. Syst., Suppl. 6, p. 543; 1907, Nordisches Plankton, Nr. 12, p. 75.

#### GENERIC CHARACTERS OF THE FREE MEDUSA.

Codonidæ with 4 rudimentary tentacle-bulbs, 4 radial-canals, and a ring-canal. Hydroid is *Corymorpha*, but distinguished by the character of its medusæ. The majority of species of *Corymorpha* hydroids do not give rise to free-swimming medusæ. Hydroid of *Amalthæa* might therefore be called *Amalthæa*. The medusæ of *Amalthæa* resemble those of *Pennaria*, but the manubrium is usually longer, and extends beyond the velar opening.

Hartlaub, 1907, includes the medusæ of *Steenstrupia*, *Euphysa*, and *Amalthæa* in the genus *Corymorpha*, for they all arise from identical hydroids; while the medusæ differ as follows: *Steenstrupia*, 3 short, and 1 long tentacle, and with an apical projection and axial canal above the stomach. *Euphysa*, similar to *Steenstrupia*, but without an apical projection or axial canal. *Amalthæa* with 4 rudimentary tentacles.

#### Amalthæa sarsii Allman (Medusa only).

*Corymorpha sarsii*, STEENSTRUP, 1854, Vidensk. Meddel. Naturhist. For. Kjöbenhavn, p. 48.—BONNEVIE, 1898, Zeit. für wissen. Zool., Bd. 43, p. 476.—HARTLAUB, 1907, Nordisches Plankton, Nr. 12, p. 86, fig. 82.
*Amalthæa sarsii*, ALLMAN, 1871, Monog. Tubularian Hydroids, p. 393.—HAECKEL, 1879, Syst. der Medusen, p. 38.
(?) *Amalthæa amœbigera*, HAECKEL, *Ibid.*, p. 38, taf. 1, figs. 10, 11.

It is not certain that this hydroid gives rise to free-swimming medusæ, though when artificially set free the medusæ swim about actively.

The bell of the attached medusa-bud is elongate with a subconical basal apex and with fairly thick bell-walls. It is 4 mm. high. There are usually 4 equally developed rudimentary tentacles, but occasionally one of the tentacles is longer than the others. Velum well developed. 4 straight, slender radial-canals. Manubrium spindle-shaped. Mouth a round opening studded with nematocysts. In the male the manubrium projects one-third its length beyond velar opening, but in the female it is shorter and the mouth is at the level of velar opening. Ova are few in number. When immature they are amœboid, but when older they become spherical and project over the surface of the gonad, attached by short pedicels. The gonad encircles the entire manubrium. Manubrium straw-yellow, tentacle-bulbs light-red. Found off coast of Norway. Hydroid: *Corymorpha sarsii*.

#### Amalthæa uvifera Schmidt.

*Amalthæa uvifera*, SCHMIDT, 1854, Nordisches Plankton, Nr. 12, p. 88, fig. 83.
*Corymorpha uvifera*, HARTLAUB, 1907, Handatlas der vergleich. Anatomie, p. 13, taf. 9, fig. 2.

This medusiform gonophore is not known to be set free. It is borne upon branched stolons which arise from the sides of the polypite above the basal circlet of long tentacles. Each stolon is tree-like and gives rise to 30 to 40 grape-like medusa-buds, so that each hydroid gives rise to more than 100 buds in various stages of development.

In the medusa-bud (when about to be set free?) there are 4 large globular, rudimentary tentacle-bulbs. The bell is higher than a hemisphere, with walls thin at apex. Manubrium

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spindle-shaped, as long as the depth of the bell-cavity. The hydroid is *Corymorpha uvifera*, found at Loppen Island, about 10 miles from Hammerfest, at a depth of about 1 fathom.

### Amalthæa vardöensis Loman.

*Amalthæa vardöensis*, LOMAN, 1889, Tijdschr., Nederland. Dierk. Ver., Ser. 2, Deel. 2, p. 271, text-fig. 5, taf. 13, figs. 1–9, 15.

Hydroid about 50 mm. high. The thin, transparent perisarc extends only over lower half of stem. The terminal polypite is sharply set off from the stem by a constriction at its base. Nearly 50 large tentacles in basal circlet at wide base of polypite. Over 100 very short tapering oral tentacles in 7 to 9 circlets. 16 to 20 peduncles arise in a circlet from the sides of the polypite between the basal and oral tentacles. Each peduncle bears a number of medusa-buds, which have 4 radial-canals and 4 equally developed, very short tentacle-bulbs. The hydroid is translucent rose-colored. Found in Busse Sound at Vardö, 71° N. lat., Norway. For details of histology, see Loman.

### Amalthæa (?) Hybocodon (?) januarii Steenstrup.

*Corymorpha januarii*, STEENSTRUP, 1854, Vidensk. Meddel. Nat. For. Kjöbenhavn, p. 46.—SARS, 1861, Annals and Mag. Nat. Hist., vol. 8, p. 356.
*Amalthæa januarii*, ALLMAN, 1871, Monog. Tubularian Hydroids, p. 394.—HAECKEL, 1879, Syst. der Medusen, p. 39.

Described by Steenstrup from a single imperfect hydroid found in the harbor of Rio Janeiro, Brazil. The hydrocaulus is about 150 mm. long and 8 mm. wide. About 80 tentacles in the proximal circlet, and these are about 50 mm. long. The oral circlet was imperfect and can not be described. There were about 40 branched peduncles above the basal circlet of tentacles. These bear numerous medusa-buds having 4 equal tentacle-bulbs, but oblique margins. The free medusæ are unknown.

## Genus PENNARIA Oken, 1815.

*Pennaria* (in part), OKEN, 1815, Lehrbuch der Naturgesch., Bd. 1, p. 94.
*Pennaria* (hydroid), GOLDFUSS, 1820, Handbuch der Zoologie, p. 89.
*Pennaria* (medusa), MCCRADY, 1857, Gymn. Charleston Harbor, p. 50.
*Pennaria*+*Halocordyle*, ALLMAN, 1871, Monog. Tubul. Hydr., pp. 363, 368.
*Pennaria*, AGASSIZ, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 278.—AGASSIZ, A., 1865, North Amer. Acal., p. 187.—HARTLAUB, 1907, Nordisches Plankton, Nr. 12, p. 72.—PEEBLES, 1903, Archiv. Entwick.-mech., Bd. 14, p. 55 (regeneration).
*Pennaria*, AGASSIZ and MAYER, 1899, Bull. Mus. Comp. Zool. at Harvard Coll., vol. 32, p. 161.—CLARKE, 1907, Mem. Museum Comp. Zool. Harvard Coll., vol. 35, p. 6.
*Globiceps*, AGASSIZ, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 344.—VANHÖFFEN, 1891, Zool. Anzeiger, p. 443.—HAECKEL, 1879, Syst. der Medusen, p. 39.
*Globiceps* (hydroid), AYERS, 1852, Proc. Boston Soc. Nat. Hist., vol. 4, p. 193.
*Eucoryne* (hydroid), LEIDY, 1855, Journ. Acad. Nat. Sci. Phila., ser. 2, vol. 3, part. 2, p. 139, plate 10, figs. 1–5.

The type-species of this genus is *Pennaria disticha* of Goldfuss, 1820, from the Mediterranean. Oken's "*Pennaria*" is wholly indefinite, including as it does *Plumularia*, *Aglaophenia*, etc.

### GENERIC CHARACTERS.

Codonidæ with 4 permanently rudimentary tentacles, which are reduced to mere basal bulbs. The hydroid stock is a *Pennaria*.

Medusæ of the genus *Pennaria* may become mature, and discharge their genital products while still attached to the hydroid, and at the same time other individual medusæ from the same stock may be set free in an immature state. Generally, however, the genital products are discharged a few hours after the medusæ are set free into the water.

There is no generic difference between the medusæ of *Pennaria* and medusæ belonging to the genus *Amalthæa*, but their hydroids are different. The hydroid stock of *Amalthæa* is *Corymorpha*, and is closely related to the hydroids of the medusa genera *Hybocodon*, *Steenstrupia*, and *Ectopleura*. The hydroid of the medusa genus *Pennaria* McCrady is *Pennaria* Goldfuss (*Globiceps* Ayers). On account of this decided difference in their hydroids we have separated *Pennaria* from *Amalthæa*=(*Corymorpha*), for their apparent similarity is only a case of parallelism.

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## Pennaria disticha Goldfuss (European).

(?) *Pennaria marina*, Imperato, 1599, Dell' historia naturale libri ventoto, Napoli, p. 747.

*Pennaria cavolini*, Schneider, 1892, Jena. Zeitsch. Naturw., Bd. 20, p. 435, taf. 14, figs. 49–54 (histology).—Du Plessis, 1881, Mittheil. Zool. Sta. Neapel, Bd. 2, p. 147.—Pictet, 1893, Revue Suisse Zool., tome 1, p. 12, plate 1, figs. 7–9.—Weismann, 1883, Entstehung Sexualzellen bei Hydromedusen, Jena, pp. 121, 218, taf. 17, figs. 1–5.—Allman, 1872, Monog. Tubularian Hydroids, pp. 364, 367, fig. 80.—Köllikер, 1847, Neue Denkschr. Schweiz. Ges. Naturw., Bd. 8, p. 49, plate 2, fig. 24.—Ehrenberg, 1834, Abhandl. d. k. Akad. d. Wissens., Berlin (1832) Teil 1, p. 297.—Gast and Godewski, 1903, Archiv. für Entwickelungs-mech., Bd. 16, p. 76, 22 figs., taf. 2, 3; 26 figs. (regulation and restitution in injured colonies).

*Pennaria disticha*, Bedot, 1901, Revue Suisse Zool., tome 9, p. 459; tome 13, 1905, p. 96 (citation of papers to 1850).—Goldfuss, 1820, Handbuch der Zool., p. 89.

*Pennaria symmetrica*, Clarke, 1879, Bull. Mus. Comp. Zool. at Harvard College, vol. 5, p. 240, plate 1, figs. 2, 3.

*Pennaria* ——, Peebles, 1903, Archiv. Entwickelungs-mech., Bd. 14, p. 55, fig. (regeneration).

*Sertularia pennaria*, delle, Chiaje, 1841-44, Animali senza vertebre del Regno di Napoli, vol. 5, pp. 5, 17, plate 157, figs. 3, 14, 15; *Ibid.*, 1822, tav. 43.

(?) *Sertularia pennaria*, Linnæus, 1758, Systema Naturæ, edit. 10, p. 813.

*Sertolara pennaria*, Cavolini, 1785, Mem. Polipi marini, Napoli, p. 134, plate 5.

*Globiceps globator*, Haeckel, 1879, Syst. der Medusen, p. 40.

(?) *Medusa, Euphysa globator*, Leuckart, 1856, Archiv. für Naturgesch., Bd. 22, p. 28, taf. 2, fig. 4.

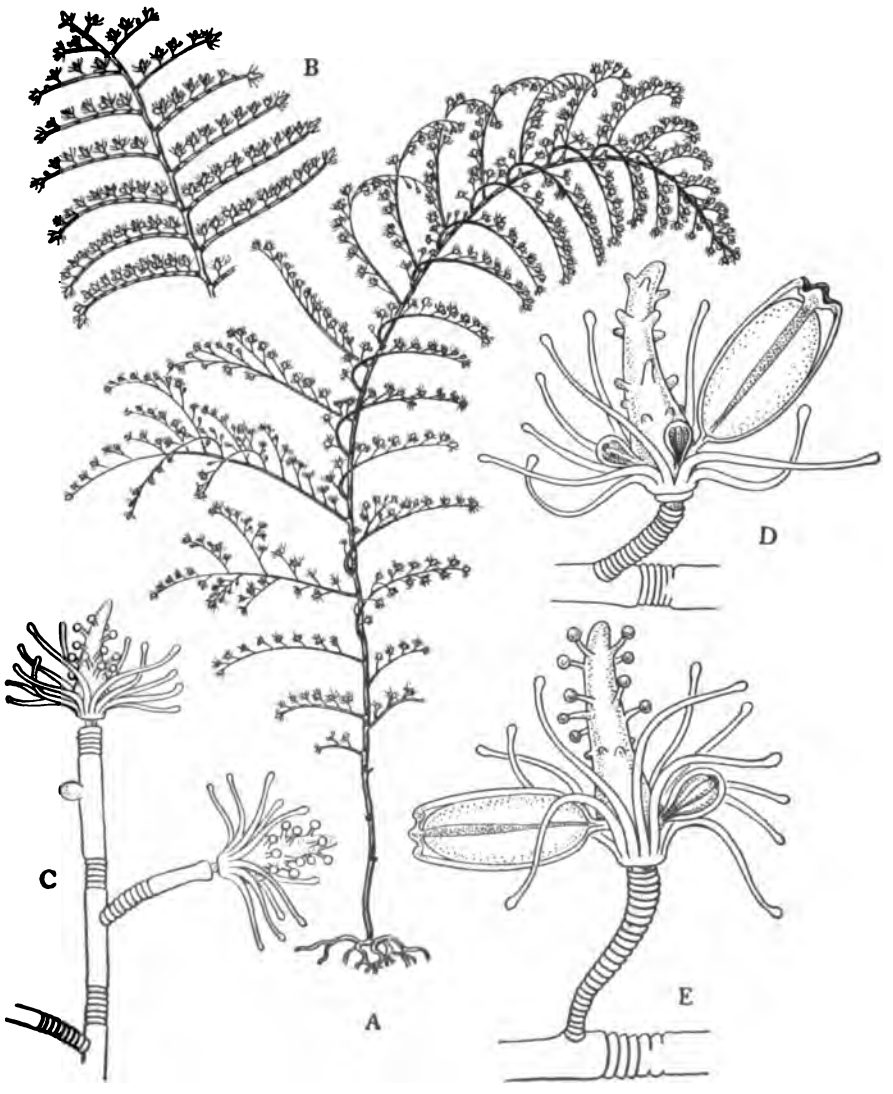


Fig. 1.—*Pennaria disticha*, from nature, by the author, from specimens collected by Dr. Lobianco in the Bay of Naples. *A*, hydrocaulus, natural size. *B*, terminal branches showing law of growth. *C*, terminal polypite. *D* and *E*, hydranths showing completely-annulated pedicels.

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This hydroid is one of the earliest forms known, yet reliable information from the systematic standpoint is still incomplete. One of the best modern descriptions is that of Allman, 1872. I believe the American "*Pennaria tiarella*" to be closely related to *P. disticha*. The only difference appears to be that the terminal ramuli in *P. disticha* are ringed throughout, whereas in *P. tiarella* they are usually ringed only at base and summit, although I have seen an occasional one ringed throughout in the American hydroid. (See W. S. Wallace, 1908, Year Book of the Carnegie Institution.)

In the European hydroid, *P. disticha*, the stems become about 150 to 175 mm. high. The main stem is slightly zigzag and with a uniform growth-curve from base to summit. There are about forty side branches, regularly alternate. Perisarc annulated at the origins of the branches and on the ultimate hydranth-bearing ramuli. Hydranths flask-shaped, with a single verticil of about 10 to 13 basal filiform tentacles each about 1 to 2 times as long as the body of the hydranth, and each ending in a blunt, slightly swollen tip. About 20 short, stiff, knobbed tentacles, irregularly arranged in 3 verticils, arise from the sides of the hydranth above the basal verticil of tentacles. The medusa-buds are similar to those of *Pennaria tiarella* and are without ectodermal ocelli upon their tentacle-bulbs. The medusæ usually wither upon the hydroid without being set free, but this often occurs also in *P. tiarella*, especially in the warm water of Florida.

Weismann, 1883, found that the germ-cells originate in the ectoderm of the inner layer of the bell-nucleus and do not wander from their place of origin, becoming mature in the free medusa, or when the medusa-bud is ripe.

Very elaborate studies upon regeneration, regulation, and restitution in injured colonies were carried out by Gast and Godewski, 1903.

This hydroid is found in the Mediterranean. Pictet, 1893, found it at Amboina, Malay Archipelago. It occurs at Naples, Italy, from May to November.

### Pennaria tiarella McCrady (American).

Plate 1, figs. 2–5.

#### References to the American Hydroid.

*Globiceps tiarella*, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 344.—Ayer, 1852, Proc. Boston Soc. Nat. Hist., vol. 4, p. 193.—Haeckel, 1879, Syst. der Medusen, p. 39.

*Pennaria tiarella*, Agassiz, A., 1865, North. Amer. Acal., p. 187, figs. 311–315.—Nutting, 1901, Bull. U. S. Fish Commission for 1899, vol. 19, pp. 337, 374, figs. 14, 83.—Hargitt, 1900, Amer. Naturalist, vol. 34, p. 387, plates 1–4, 36 figs.; Bull. of the Bureau of Fisheries U. S., for 1904, vol. 24, p. 32, plate 3; 1904, Archiv. für entwickelungs-mech. organism, Bd. 18, p. 453, taf. 24–28; 1902, Amer. Naturalist, vol. 35, p. 311, figs. 8, 9; p. 597, fig. 36; 1899, Biol. Bulletin Woods Hole, vol. 1, p. 35–40, 6 figs. (grafting experiments); 1900, Science, New series, vol. 12, p. 340; and 1901, Biol. Bulletin Woods Hole, vol. 2, p. 223 (variations of hydroids and medusæ.)—McCrady, 1857, Gymn. Charleston Harbor, p. 51.—Smallwood, 1899, American Naturalist, vol. 33, p. 861, 7 figs. (histology).—Hartlaub, 1907, Nordisches Plankton, Nr. 12, p. 72, figs. 68–70.—Goldfarb, 1906, Journ. Experimental Zool., vol. 3, p. 148 (regeneration).

*Pennaria tiarella*=(*P. symmetrica*, Clarke), Congdon, 1907, Proc. American Acad. Arts and Sci., vol. 42, p. 464.

*Pennaria, sp.*, Thacher, 1903, Biol. Bulletin, vol. 4, p. 96.

*Pennaria gibbosa*, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, pp. 278, 344; vol. 3, plate 15, figs. 1, 2.

*Halcerdyle tiarella*, Allman, 1871, Monog. Tubul. Hydroids, p. 369.

*Eucoryne elegans*, Leidy, 1855, Marine Invert. N. J. and R. I., p. 4, plate 10, figs. 1–5.

#### The American Pennaria.

*Medusa.*—The bell is about 2 mm. in height, and is ellipsoidal, being higher than it is broad. Bell-walls very thin, flexible, and much distorted by the remarkably large ova, which are situated within the ectoderm of the manubrium and often fill the entire cavity of the bell. There are 4 small, rudimentary tentacle-bulbs, without ocelli, 1 at the base of each radial-canal. Radial-canals straight and quite broad. Velum wide and powerful. Manubrium of male more slender than that of female, the latter being usually greatly distended with 4 or 5 large ova. Several ova are often set free into the water before the medusa is liberated from the hydroid stock. The medusa is commonly mature at the time of its liberation, and it is probable that it does not usually survive for more than a few hours, though Dr. A. Agassiz has maintained them alive for several weeks. The entoderm of the manubrium is rose-pink, and there are a number of deep-pink blotches in the entoderm of each radial-canal. The entoderm of the tentacle-bulbs is pearly-white, as are also the eggs within the manubrium. These colors vary considerably in hue and may be almost white.

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*Hydroid.*—The hydroid is very abundant upon eel-grass, seaweeds, stones, or wharves, below low tide. The stems arise from a ramifying stolon. They attain a height of 100 to 125 mm. The main stems branch alternately, the longest and oldest side branches being found nearest the base of the stock. The side branches give rise to simple or slightly branched ramuli from their upper sides. These ultimate ramuli are annulated at base with 5 to 6 rings, and the main stem and primary branches are annulated beyond each branch. The stems are covered with a chitinous, horny perisarc. The polyp-heads are flask-shaped, and the mouth is situated at the extremity of a long, slender, conical throat-tube. There are 2 or 3 verticils of oral tentacles, each row being composed of 5 to 7 short, stiff tentacles, each terminating in a knob-shaped cluster of nematocysts. Besides these there is a single circlet of 12 to 16 long, flexible tentacles near the proximal base of the polypite. The medusa-buds develop upon the sides of the polypites between the oral and basal rows of tentacles. There are usually not more than 2 or 3 buds upon each polypite at the same time. The entoderm of this hydroid is white to rose-colored, the ectoderm silvery and translucent, and the perisarc horny-yellow to black.

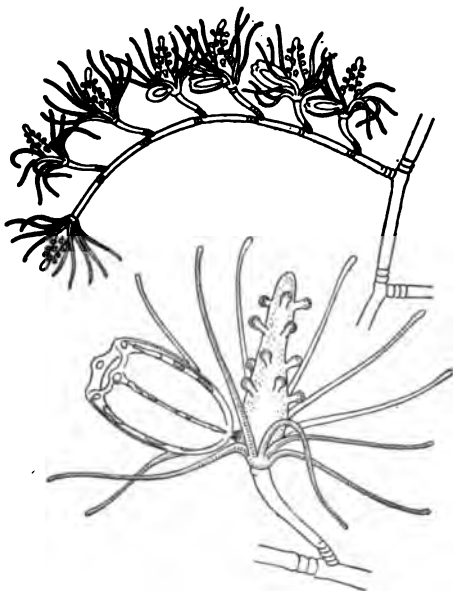

FIG. 2.—Southern variety of *Pennaria tiarella*. From life, by the author, Tortugas, Florida, May 27, 1908.
Branch of hydroid and enlarged view of a polypite showing pedicels ringed only at their bases.

This hydroid ranges from the West Indies and Bermudas to the coast of Maine. *Pennaria gibbosa* L. Agassiz, of the Florida coast and West Indies, is probably identical with *P. tiarella*, but the medusæ of the southern form wither on the stem as do those of *P. disticha*. Indeed Agassiz's figure in 1862, shows the ultimate pedicels of his *P. gibbosa*, from Key West, Florida, ringed throughout as in the Mediterranean *Pennaria disticha*.

Hargitt, 1900, has made a study of the life-history and development of *P. tiarella*. Early in the summer the hydroids are found growing on rock-weed, piles of docks, etc.; while late in the summer they take to eel-grass. The early summer brood is not so bright in color, and the medusæ mature more slowly than in the late brood. The individual hydranths of the late brood are, however, smaller than those of the early summer brood. The medusæ discharge their ova soon after liberation, and then die rapidly. The ova are 0.4 to 0.5 mm. in diameter and are heavily laden with yolk. They are creamy-white to orange in color. The cleavage is found by Hargitt to be subject to much individual variability, so that an extraordinarily irregular, loosely connected mass of cells is formed, resembling the condition described by Rittenhouse, 1907, in *Turritopsis nutricula*. No matter how irregularly shaped the embryo may be, it results finally in the formation of a spherical solid morula, and this soon changes into a pear-shaped, ciliated, planula larva. In 5 to 7 days after the beginning of development, the larvæ settle down and then develop into small monogastric hydroids covered with ringed perisarc, and provided with whorls of tentacles as in the adult. Hargitt finds that the removal of small parts of the segmenting eggs does not alter the future history of development. The eggs may also be divided at the first or second cleavage and will still develop into normal larvæ. Moreover, Hargitt finds that single eggs sometimes separate normally into two masses, each of which gives rise to a normal embryo. The irregularities in cleavage observed by Hargitt have been seen also by Miss Cora J. Beckwith. She finds that the segmentation is mytotic, not amitotic; the nuclear division constantly outnumbering the cytoplasmic so that a syncytium is formed.

Hargitt, 1901, states that hydroid stocks of *Pennaria* which grow upon eel-grass in shallow water are more pinnatified in their branching, and more highly colored than are those which grow upon stones, etc., in deep water. He also finds that the medusæ of the deep-water hydroids are less active than are those developed upon the hydroids which grow in shallow

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water, and are often retained until they wither upon the stems after having cast out their genital products.

I have found only the pale form of *Pennaria* on the Florida Reefs, and its medusæ appear to cast out their genital products before being set free, as is described by Hargitt for the deep-water forms of Woods Hole, Massachusetts. In Florida, *Pennaria* grows in tuft-like clusters upon gorgonians. This tropical form is called *Pennaria gibbosa* by L. Agassiz, but those seen by me can not be separated from the *Pennaria* of the coast of New England.

Hargitt, 1899, carried out a series of grafting experiments upon *Pennaria* and other hydroids. He finds that pieces of hydroids of the same species may readily be grafted one upon the other, both in oral or aboral relations, there being little or no evidence of polarity in the regenerative process. Pieces of opposite sex but of the same species will readily unite in any manner, but pieces belonging to hydroids of different genera would not unite. Elaborate studies of this character were also carried out by Gast and Godewski, 1903, on *P. disticha*.

In 1900 and 1901, Hargitt studied the variations of the medusæ and hydroids of *Pennaria*. The medusa sometimes displays ectodermal blister-like protrusions on its exumbrella, and is variable in other respects.

According to H. Müller, 1907 (Zeit. für wissen. Zool., Bd. 89), the eggs of *Pennaria* develop at the expense of the weaker egg-cells of the ovary, which they engulf as food to form the yolk-granules.

Thacher, 1903, shows that in *Pennaria*, *Campanularia*, and *Eudendrium*, the hydranths, when they degenerate, are absorbed not by liquefaction of their protoplasm, or by the withdrawal of the polyps as a whole; but absorption takes place by the degenerating cells of both ectoderm and entoderm being turned into the digestive tract of the hydroid.

Goldfarb, 1906, finds that light is absolutely essential for the normal growth, development, and regeneration of *Pennaria*. He finds, however, that this is true in a sense also for *Eudendrium*, but not to the same degree, for *Eudendrium ramosum* colonies, kept in the dark until all the influence of their previous illumination has been lost, will not then regenerate new hydranths unless they be again exposed to light; but the surprisingly short exposure to light of only 5 seconds will suffice to restart the regenerative process.

### Pennaria rosea von Lendenfeld.

*Pennaria rosea*, VON LENDENFELD, 1884, Proc. Linnean Soc. New South Wales, ser. 1, vol. 9, p. 594, plate 24, figs. 40, 42.—BALE, 1888, *Ibid.*, ser. 2, vol. 3, p. 747=*P. australis*, BALE, 1884, in Cat. Australian Hydroid Zoophytes, p. 45.

Main axial stems 80 mm. long, with about 20 alternately arranged, pinnate side branches. 4 to 6 hydranths on each branch. Hydrorhiza and main stems intensely black and opaque; outer half of each stem light-yellow, proximal half intense black. Hydranths rose-colored, with 9 to 14 oral, and 7 to 12 filiform, basal tentacles. Medusæ are produced on the proximal hydranths. The medusa bell is slender, oval, 2 mm. high, 1 mm. wide. 4 large rudimentary tentacle-bulbs with a minute external ocellus upon each. Manubrium with sperm or ova fills the entire cavity of subumbrella. Ova discharged after medusa is set free. Color, intense rose.

Coast of New South Wales, Australia. Mature in May.

This species is distinguished from the European and American *Pennaria* by its tentacular ocelli.

### Pennaria adamsia von Lendenfeld.

*Pennaria adamsia*, VON LENDENFELD, 1884, Proc. Linnean Soc. New South Wales, vol. 9, p. 595, plate 25, figs. 45-48; plate 26, fig. 49.

*Medusæ*.—The male medusæ are 1.5 mm. long and only 0.7 mm. wide; while the female medusæ are 1.5 mm. long and as broad as they are high. The male medusæ have 4 radially situated marginal tentacles, about as long as the width of the bell. These tentacles have well-developed basal bulbs with minute ocelli, and the tentacles move about freely. The spermatozoa fill the space between the manubrium and the sides of the subumbrella, and are discharged within an hour after the medusa has been set free. The female medusæ are broad, and the tentacles are mere rudiments without ocelli. The bell-cavity is filled with ova, which are soon discharged.

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*Hydroid.*—The stems are 60 to 80 mm. long, zigzag, and with 15 to 20 alternate branches. The longest branches are nearest the base and are about 12 mm. long. There are about 8 hydranths, 1.7 mm. long, on each branch. These hydranths are slender, the proximal ones only about half as large as the distal primary one on each branch. There are 2 verticils of oral tentacles, each with 4 tentacles alternating in position with those of the other row. These oral tentacles are short and each ends in a nematocyst-knob. The uppermost row of 4 oral tentacles is in the 4 perradii, and the lower row in the 4 interradii. There are 24 long filiform tentacles in a single row at the broad base of the polypite. These are about as long as the polypite itself. The perisarc of the hydrorhiza and main stems is opaque and black, and the side branches are yellow. The hydranths are white.

Coast of New South Wales, Australia. Medusæ are produced in March.

This species is distinguished by the minute ectodermal ocelli upon the tentacle-bulbs of the male medusæ, and by the length of its tentacles. There are also but 2 verticils of oral tentacles.

**Pennaria pacifica Clarke.**

*Pennaria pacifica*, CLARKE, 1907, Mem. Museum Comp. Zool. Harvard Coll., vol. 35, No. 1, p. 6, plate 1, figs. 1–6.

Hydrocaulus 20 to 35 mm. high. Internodes of the main stem without annulations at their distal ends, and with only 1 or 2 rings at their proximal ends. Branches alternate. Peduncles taper slightly to the base where there are 2 or 3 annulations. Hydranths with 12 to 14 filiments, and about 16 capitate tentacles somewhat irregularly arranged.

Pinco Island, Gulf of Panama, tropical Pacific.

Distinguished only by its few annulations at the internodes of the main stem. It is probably only a local variety of *P. tiarella*.

**Pennaria ? vitrea Agassiz & Mayer.**

*Pennaria vitrea*, AGASSIZ and MAYER, Bull. Mus. Comp. Zool. at Harvard Coll., vol. 32, p. 161, plate 1, figs. 1, 2.

Bell is 3 mm. in height; walls thick and rigid. There are 4 rudimentary tentacle-bulbs. Velum not prominent. The 4 radial-canals are straight and narrow. The manubrium in the female specimen was retracted within the cavity of the bell, but it was flask-shaped in the male and projected for a short distance beyond the velar opening. These conditions, however, may be merely different states of contraction and not constant differences; but as we observed only two individuals, one a male and the other a female, we can not be certain upon this point. The ova are large and pyriform, and are grouped in 4 interradially arranged clusters within the manubrium. The mouth-opening is simple, and there are no fimbriations or appendages.

Prominent circular muscles were observed in the ectoderm of the cavity of the bell in the female, but these were not seen in the case of the male. It is possible, however, that they become apparent only during certain states of contraction. In the female the ova and tentacular bulbs were flesh-colored, and the entoderm of the mouth was green. In the male the tentacular bulbs were green, the entoderm of the manubrium pink, and the lips green.

Found among the Fiji Islands, off Kimbombo Island, November 25, and off Mbatiki Island, December 5, 1897.

Not having seen the hydroid I am very doubtful concerning the generic identity of this medusa with *Pennaria*.

**Genus TRICHORHIZA Russell, 1906.**

*Trichorhiza*, RUSSELL, 1906, Proc. Zool. Soc. London, p. 99, plate 5.

GENERIC CHARACTERS.

The medusa is similar to that of *Pennaria*, but with one tentacle-bulb somewhat better developed than the 3 others. The hydranth is solitary, with a branched, filiform hydrorhiza. The perisarc forms a cup into the cavity of which the hydranth may be partially retracted. There are 2 verticils of tentacles, an oral and a basal; and the medusa-buds arise from the sides of the hydranth between these 2 verticils. The type-species is *Trichorhiza brunnea* Russell, from the Firth of Clyde, Scotland.

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### Trichorhiza brunnea Russell.

*Trichorhiza brunnea*, Russell, 1906, Proc. Zool. Soc. London, p. 99, plate 5, figs. 1-2; Abstract, Proc. Zool. Soc. London, No. 26, p. 6, Feb. 13, 1906.

Mature medusa unknown. When newly set free from the hydroid the medusa is pyriform, with a thin-walled bell, well-developed velum, and 4 rudimentary tentacle-bulbs, one of which is larger than the others. The manubrium when extended is as long as the depth of the bell-cavity, and it is cylindrical, narrow, and provided with a simple, circular mouth-opening which is surrounded by nematocysts. There are 4 simple, straight radial-canals, but no gonads. The manubrium and tentacle-bulbs are yellow, the former being faint and the latter golden in color.

This medusa is liberated by a solitary hydroid which was found on June 29, 1905, at a depth of 17 fathoms in Ethick Bay, Bute, Firth of Clyde, Scotland. The hydrorhiza of the *Trichorhiza* was entwined among and around the tentacles of *Corymorpha nutans*. The hydroid is 11 mm. in total length, the hydranth itself being only 1.5 mm. long. The hydrorhiza is long, filiform, and sparingly branched, with about 6 simple branches which arise from its lower (aboral) half. The cœnosarc does not appear to extend over this branched lower half of the hydrorhiza. Above the upper end of the hydrorhiza the perisarc extends to form a cup-like hydrotheca, which bears 4 transverse grooves. Immediately below this hydrotheca the perisarc displays several longitudinal lines. Hydranth conical, 1.5 mm. long and 0.8 mm. wide, with an oral circlet of 7 very short tentacles having knob-shaped ends. There is also a basal circlet of 12 filiform tentacles, which are ringed with nematocysts and are tapering, and fully as long as the hydranth itself. 8 or 10 medusa-buds arise at various levels from the sides of the polypite between the basal and oral circlets of tentacles.

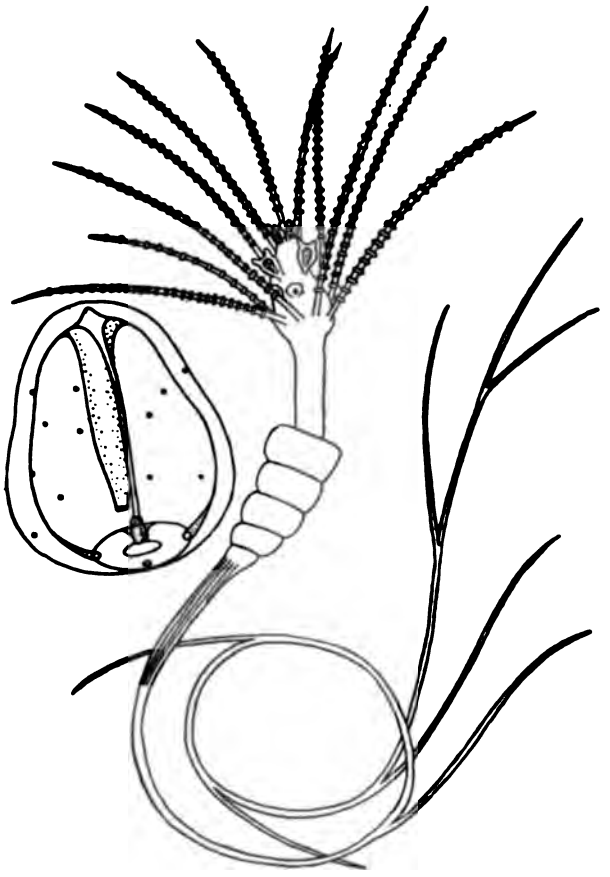

Fig. 3.—*Trichorhiza brunnea*, after Russell, Proc. Zool. Soc., London, 1906. Hydroid, and enlarged view of recently liberated medusa.

The perisarc of the hydrorhiza is straw-colored, and that of the hydrotheca chocolate-colored. Body of hydranth pale reddish-brown, tentacles translucent white.

This hydroid bears some resemblance to *Blastothela* of Verrill, 1878, Amer. Jour. Sci., ser. 3, vol. 16, p. 374.

### Genus STEENSTRUPIA Forbes, 1846.

*Steenstrupia*, Forbes, 1846, Annals and Mag. Nat. Hist., vol. 18, p. 287.—Leuckart, 1856, Archiv. fur Naturgesch., Bd. 22, p. 29.
*Steenstrupia + Euphysa*, Haeckel, 1879, Syst. der Medusen, pp. 29, 31.—Browne, 1895, Trans. Liverpool Biol. Association, vol. 9, pp. 247, 248.
*Euphysa + Steenstrupia*, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, pp. 342, 343.—Haeckel, 1864, Jena. Zeitsch. fur Naturw., Bd. 1, pp. 338, 339.—Forbes, 1848, British Naked-eyed Medusæ, pp. 71, 72.
*Euphysa*, Agassiz, A., 1865, North Amer. Acal., p. 189.—Bigelow, 1904, Bull. Mus. Comp. Zool. at Harvard Coll., vol. 39, p. 251.—Vanhöffen, 1891, Zool. Anzeiger, Bd. 14, p. 443.
*Euphysora*, Maas, 1905, Hydromedusen der *Siboga* Expedition, p. 6.
*Heterostephanus + Steenstrupia + Euphysa*, Hartlaub, 1907, Nordisches Plankton, Nr. 12, pp. 74, 76, 80.

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The type-species of this genus is *Steenstrupia rubra* Forbes, 1846, from the Atlantic coasts of Europe.

GENERIC CHARACTERS.

Codonidæ with radially symmetrical bell, and with 4 radially situated tentacles, 1 of which is well developed while the 3 others are short or rudimentary.

This genus is separated from *Hybocodon* by its radially symmetrical bell. In *Hybocodon* 1 radial-canal is long, 1 short, and 2 of medium length; but in *Steenstrupia* the 4 radial-canals are all of the same length.

*Synopsis of the Characters of Medusæ of the Genus Steenstrupia.*

| | S. rubra Forbes = S. flaveola Forbes = S. galanthus Haeckel = (?) E. gracilis Brooks = (?) S. cranoides Haeckel = S. lineata Leuckart. | S. aurata = Euphysa aurata Forbes, = E. aurata + E. mediterranea Haeckel = (?) E. virgulata A. Agassiz. | S. tetrabrachia = E. tetrabrachia H. B. Bigelow. | S. bigelowi Maas. | S. australis von Lendenfeld. |
|---|---|---|---|---|---|
| Shape and size of bell in mm. | Bell has well-developed apical projection. 5 high, 3 wide. | Dome-like apex. Cylindrical sides. 6 high, 4.5 wide. Bell-walls and apex thick. | Pyriform. 4 high, 2.5 wide. | Pyriform. 10 high, 5 wide. | Half-egg-shaped. 2.5 high, 1.7 wide. |
| Condition of tentacles. Length in terms of bell-radius (*r*). | 3 long, narrow tentacle-bulbs without tentacles, all similar. 1 long tentacle ringed with nematocysts. Length = 7 *r*. | 3 small, similar, rudimentary tentacle-bulbs. 1 long tentacle. Length = 2 *r* +. No ocelli. No definite rings of nematocysts on tentacles. | 3 short tentacles, each = *r* long. 1 large tentacle about 7 *r* long. All tentacles sparsely ringed. | 3 short tentacles about 2 *r* long and not ringed. One long tentacle 4 *r* long, with many prominent partial rings of nematocysts. | 3 tentacle-bulbs, and 1 long tentacle, ringed with nematocysts. Long tentacle about 8 *r* long. |
| Axial-canal above stomach. | Axial canal always present. | No axial-canal. | No axial-canal. | Present. Small, slender. | No axial-canal. |
| Length of manubrium in terms of bell-radius (*r*). | 1.5 *r*. Stomach mounted on short peduncle. | 1.25 *r*. No peduncle. | 2.5 *r* long. Mounted on very short peduncle ? Mouth extends slightly beyond velar opening. | 1.5 *r* long. Mouth not quite reaching level of velar opening. | 1.5 *r* long. Cylindrical. |
| Gonads. | Single gonad encircles stomach, leaving mouth and peduncle free. | Single gonad encircles stomach. | Eggs developed in 8 adradial, longitudinal rows, in ectoderm on sides of stomach. | 4 wide interradial, ectodermal swellings on sides of mid-region of manubrium. Separated by 4 narrow, perradial spaces. | Gonad encircles manubrium. |
| Color. | Tentacle-bulbs and stomach light-pink to reddish-brown. Bell apex sometimes faint pink. | Variable. Tentacle-bulbs may be yellow, orange, red, or colorless. Manubrium reddish to yellow or faint purple. | Gonads brownish-yellow. Mouth pink. Tentacle-bulbs and rings pink. | Entoderm of manubrium, canals, and tentacles dull yellow. | Mouth deep violet. 4 brown patches on gonad. Tentacle-bulbs and long tentacle brown with violet spots. |
| Where found. | Atlantic coasts of Norway, Germany, England, Scotland, and Ireland. (Mediterranean ?) (Southern United States, Atlantic coast ?) | Mediterranean and Atlantic coasts of Europe. | Suvadiva Atoll, Maldive Islands, Indian Ocean in January. | Malay Archipelago. | Harbor of Sydney, New South Wales, Australia. |
| Hydroid. | Corymorpha nutans, Sars, 1835; Hincks, 1868; Allman, 1871. | Corymorpha nana, Alder, 1857. | Unknown. | This medusa is probably identical with S. tetrabrachia. Hydroid unknown. | Unknown. |

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The hydroid generation is *Corymorpha* Sars, 1835=*Halatractus* of Allman, 1871.

Haeckel, 1879, restricts *Steenstrupia* to describe medusæ having characters as above, but with an apical projection upon the bell, and with an axial canal extending upward into this projection from the stomach. *Euphysa* he would restrict to include forms which lack an apical projection and an axial canal. As Vanhöffen, 1891, rightly states, an apical projection is always lacking in young medusæ and is highly variable in its development even in mature individuals of the same species. The same is true of an axial canal. Moreover, among species discovered since Haeckel wrote his "System der Medusen," *Euphysa tetrabrachia*, Bigelow, 1904 (Bull. Mus. Comp. Zool. at Harvard Coll., vol. 39, p. 251, plate 1, fig. 1), has a well-developed apical projection, and no axial canal, and would therefore have no place in Haeckel's system.

Maas, 1905, would institute a genus *Euphysora* to describe Codonidæ having 1 large, and 3 well-developed but still considerably smaller tentacles. Here again, however, we meet with a condition of degree only. When, for example, are the 3 small tentacles large enough to be *Euphysora* or small enough to be *Steenstrupia*? In order to avoid confusion, it appears best to combine all of these forms under one generic name. Vanhöffen, 1891, suggests *Euphysa* as the proper generic name to include all of these forms, but *Steenstrupia* takes precedence over *Euphysa*, for it was used by Forbes in 1846, while *Euphysa* was first used by him in 1848.

Bigelow finds that the eggs of *S. tetrabrachia* are arranged in 8 adradial longitudinal lines in the ectoderm of the stomach, and Maas states that in *S. bigelowi* the gonads are interradial and separated by very narrow linear interspaces in the 4 principal radii. These conditions are interesting, for they foreshadow those characteristic of the Oceanidæ where the gonads are interradial or adradial, and are often quite widely separated in the principal radii.

Hartlaub, 1907, defines *Heterostephanus* (Allman, 1871) as a *Steenstrupia*-like medusa-bud, not known to be set free from its *Corymorpha*-like hydroid. Medusa with a single tentacle, ringed at its base, and terminating distally in a knob. The only known species is *H. annulicornis*, Allman, 1871=*Hybocodon annulicornis* Haeckel. This was first described by M. Sars, 1859, as *Corymorpha? annulicornis*.

### Steenstrupia rubra Forbes.

Plate 1, fig. 7.

*Corymorpha nutans* (hydroid), Sars, M., 1835, Beskriv. og Jagtt., p. 6, plate 1, fig. 3; Sars, O., 1877, Fauna Littor. Norveg., tome 3, p. 2, taf. 2, figs. 25–28.
*Corymorpha nutans* (hydroid), Bedot, 1905, Revue Suisse de Zool., tome 13, p. 63 (literature to 1850).
*Corymorpha nutans* (hydroid and medusa), Hartlaub, 1907, Nordisches Plankton, Nr. 12, p. 76, figs. 72–75 (complete list of authors, localities, and best modern description of hydroid and medusa).
*Corymorpha nutans*, Hincks, 1868, Hist. British Hydroid Zoophytes, p. 127, plate 22.—Allman, 1871, Monog. Tubularian Hydroids, p. 388, plate 19.
*Corymorpha nutans*=*S. galanthus* (Haeckel)=*S. flaveola*, Forbes=*S. rubra*, Forbes, Browne, 1896, Proc. Zool. Soc. London, pp. 463, 464, plate 16, fig. 1 (review of literature).
*Steenstrupia galanthus*, Bedot, 1905, Revue Suisse de Zool., tome 13, p. 148 (literature to 1850).—Haeckel, 1879, Syst. der Medusen, p. 31. *Hybocodon nutans*, *Ibid.*, p. 34.—Müller, 1908, Zeit. für wissen. Zool., Bd. 89, p. 52, taf. 5, figs. 20–24 (origin and structure of the eggs).
*Steenstrupia rubra*, Hartlaub, 1904, Wissen. Meeresuntersuch. Kommiss. Meere Kiel, Abth. Helgoland, Neue Folge, Bd. 5, p. 105, fig. 3.
*Steenstrupia rubra* (Forbes), Browne, 1895, Trans. Liverpool Biol. Soc., vol. 9, p. 247.
*Steenstrupia rubra* (medusa)+*S. flaveola*, Forbes, 1848, British Naked-eyed Medusæ, pp. 73, 74, plate 13, figs. 1, 2.
*Steenstrupia cranoides*, Haeckel, 1879, Syst. der Medusen, p. 30, taf. 2, figs. 10–14.
*Steenstrupia gracilis*, Brooks, 1882, Studies Johns Hopkins Univ. Biol. Laboratory, vol. 2, p. 144.—Mayer, 1900, Bull. Mus. Comp. Zool. at Harvard Coll., vol. 37, p. 29, plate 16, figs. 36, 37.
*Steenstrupia lineata*, Leuckart, 1856, Archiv. für Naturgesch., Bd. 22, p. 29, taf. 2, fig. 6. –Spagnolini, 1876, Catalogo Acalefi Mediterraneo, p. 17, taf. 1, figs. 1–4.—Haeckel, 1879, Syst. der Medusen, p. 30.—du Plessis, 1888, Recueil Zool. Suisse, tome 4, p. 543.

This medusa is found on the coasts of Europe from Norway southward to the Mediterranean. *S. cranoides* Haeckel=*S. lineata* Leuckart, from the Mediterranean, appears to be identical with *S. rubra*. *S. gracilis* Brooks, of the Atlantic coast of the United States south of Virginia, is probably identical with *S. rubra* of Europe, but the hydroid of the American form remains unknown. I believe that *S. lineata*, *S. cranoides*, and *S. gracilis* are identical, and that they are probably identical with *S. rubra* Forbes.

For description of *S. rubra* of Europe, see synoptic table of species of *Steenstrupia*.



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In the American form the development of nematocyst-rings upon the long tentacle is subject to great variability. The Mediterranean *S. cranoides* Haeckel lacks such rings, whereas they appear to be better developed in northern Atlantic specimens from the coasts of Europe. The same difference appears to be exhibited by our American specimens, those from Tortugas, Florida, being unringed or only slightly ringed, while those from North Carolina are often profusely ringed. The apex of the bell often bristles with nematocysts, but in some medusæ it may be smooth.

Browne, 1896 (pl. 16, fig. 1), gives a figure of *S. rubra* derived from specimens found by him at Valencia Island, off the Irish coast. He shows a narrow conical peduncle above the stomach, the peduncle being about one-fifth as long as the gastric portion of the manubrium. No such peduncle has been observed in the American *S. "gracilis,"* when the bell is expanded, although when it is somewhat contracted the appearance of a well-developed peduncle is often produced. On the other hand, when the stomach is widely distended with food and the bell expanded no peduncle may be seen. Haeckel's series of figures (taf. 2, figs. 10–12) will

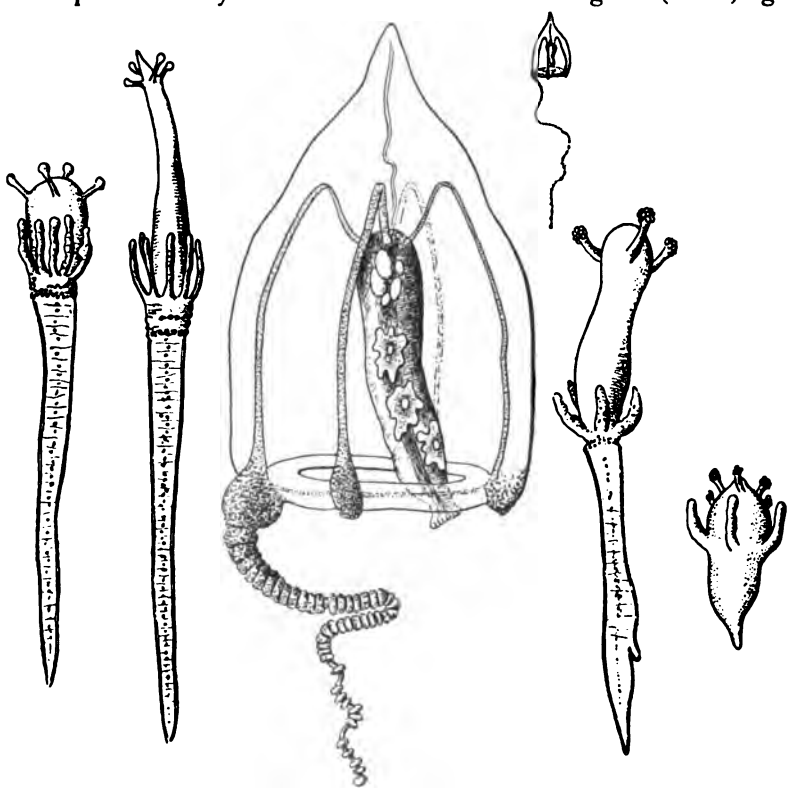

FIG. 4.—*Corymorpha nutans*, after Hartlaub, in Nordisches Plankton.
(Young hydroids and mature medusa.)

serve to illustrate the formation of a peduncle-like body of gelatinous substance above the stomach through contraction of the bell. I have frequently seen the same phenomenon in our American *S. "gracilis"* = *S. cranoides* Haeckel. I have also observed this peduncle in living medusæ of *S. rubra* taken off the coast of Cornwall, England.

Hartlaub, 1907, gives a list of the bibliography and of localities for this species, and his description of the medusa and the young hydroid are the best yet produced (see fig. 4).

The egg is amœboid as in *Amalthæa*. The young hydroid has a single circlet of 4 short, knobbed, oral tentacles, and another circlet of 5 to 8 simple, flexible, filiform basal tentacles. H. Müller, 1908, finds that the full-grown eggs are very few in number, having developed at the expense of other weaker egg-cells in the ovary, which they devour. The exoplasma is quite wide and is separated from the germinal vesicle. The ooplasma is a network of delicate fibers of wide mesh, and the exoplasma and endoplasma are distinct, one from another. The egg contains numerous pseudo-cells in advanced stages of degeneration and also yolk-granules.

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The following description of the medusa is derived from a study of specimens found by the author off the coast of the United States:

The bell is 5 mm. high and surmounted by a slender conical projection about 2 mm. long. There are 4 tentacles. One of these is about 10 mm. long, and is ringed at irregular intervals by prominent swellings, between which there are small rings at fairly regular inter-

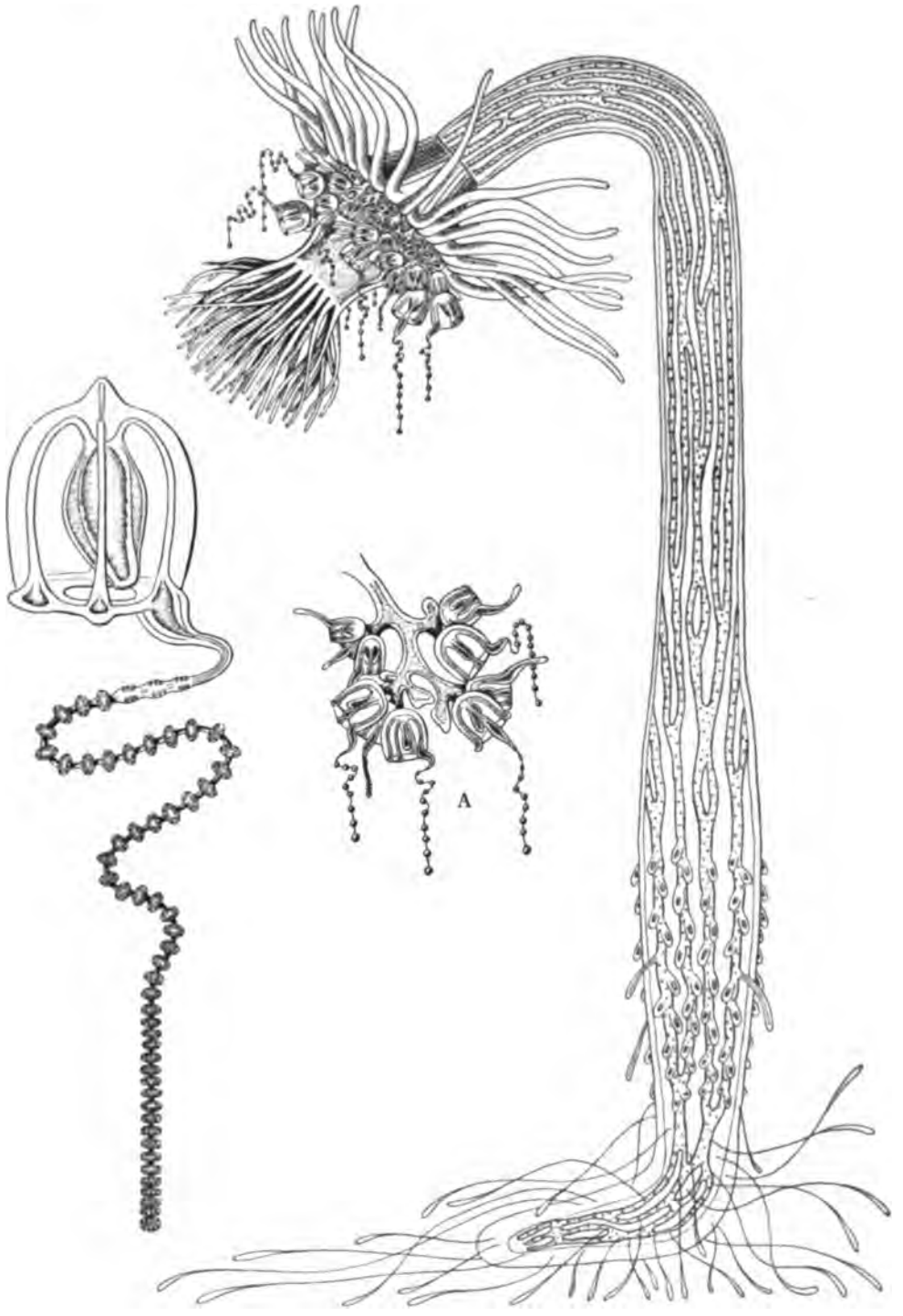


FIG. 5.—*Corymorpha nutans*, hydroid and medusa, after Allman, in Ray Society, 1871–72.
*A*. Detail showing manner in which medusæ bud off from hydranth.

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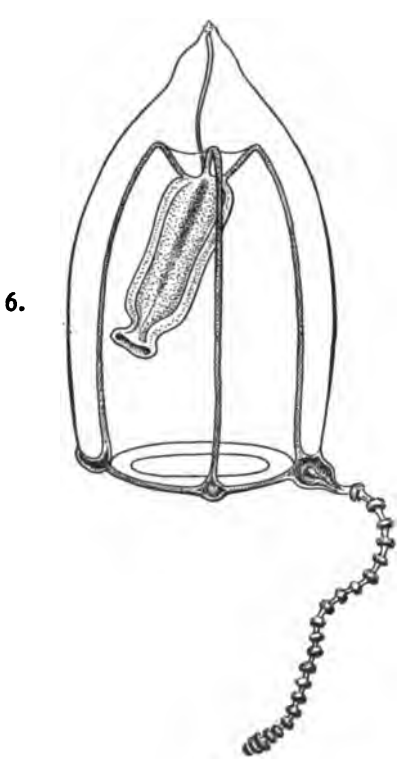
vals. The tentacle which is diametrically opposite to the long tentacle is tapering, and about 0.25 mm. long; while the 2 other tentacles are mere bulbs. The velum is well developed. There are 4 narrow radial-canals, and a slender ring-canal. A long, slender, sinuous canal extends from the aboral apex of the stomach upward into the apical projection of the bell. In mature medusæ the manubrium extends a short distance beyond the velar opening. Ordinarily the mouth is a simple, round opening at the tapering extremity of the manubrium, but when widely open, as in our figure, it shows 4 thick but not prominent lips. The genital products are found in the manubrium, and in the female the eggs project from the surface of the ectoderm. Entoderm of manubrium intense yellow-green and rose-color. Apical canal intense yellow, often flecked with rose-color. The entoderm of the tentacle-bases is rose-color and yellow, while the entoderm of the large annular swellings is rose-color. When young the apical projection is not very high, the tentacles short, and without nematocyst-rings, and the manubrium short and tapering; not extending beyond the velar opening as in the mature medusa.



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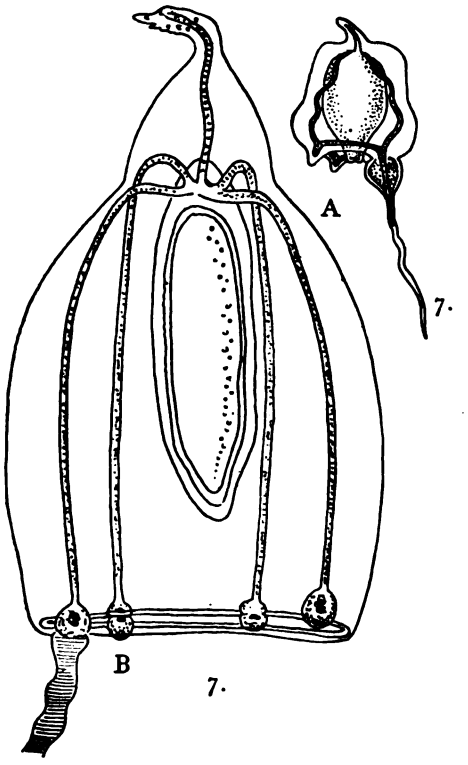


7.

FIGS. 6 and 7.—*Steenstrupia rubra.*

6.—From life, by the author. Off Mousehole, Cornwall, England, October 23, 1907.
7.—*A.* After Leuckart ("*S. lineata*"), 1856, Archiv. fur Naturgesch., Bd. 22.
*B.* After Spagnolini ("*S. lineata*"), 1876, Catalogo Acalefi Mediterraneo.

Found at Oregon Inlet, Pamlico Sound, North Carolina, in November, and at Beaufort, North Carolina, and Tortugas, Florida, in summer. It is apparently identical with *S. cranoides* and *S. lineata* of the Mediterranean.

Definite rings of nematocysts are not found upon the tentacles of the young medusa, and are very variable in their development in mature specimens, some being profusely ringed and some entirely unringed. Haeckel describes only unringed individuals from the Mediterranean, his specimens being similar to those found by me at Tortugas, Florida.

I am inclined to believe that this Mediterranean and tropical American medusa will prove to be identical with, or only a variety of, *S. rubra* of the Atlantic coasts of western Europe. Certainly no differences, other than those well within the limits of common variability, can be detected between the medusæ of *S. rubra* and *S. lineata*=*S. cranoides;* but a

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careful comparative study of the hydroids of these forms must be made before we may safely assert either that they are identical or separate species.

The hydroid of *S. rubra* is *Corymorpha nutans* of Sars, and is common on sandy bottoms, off the northern coasts of Europe, at moderate depths. The stems of the hydroid are solitary, and are about 50 to 75 mm. high, and about 4 mm. wide at the widest part. The whole stem is corrugated by numerous narrow longitudinal bands. The widest part of the stem is usually at a short distance above the lower end. This lower end is bent sharply at right angles to the main part of the stem and bears long, hair-like filaments which serve to anchor the hydroid. There are also blunt, papilla-like processes which arise from the sides of the stem above the bent portion. The polypite is large and flask-shaped, and has a basal zone of 30 or more long, tapering tentacles, about as long as the polypite itself. In addition to these tentacles there are 6 to 7 closely crowded verticils of oral tentacles, which are much shorter and thinner than the proximal. 15 to 20 branched peduncles arise from the sides of the polypite close to the bases of the proximal circlet of tentacles, and bear the medusa-buds. The hydranth is light-red, the stem being paler than the polypite. On the English coast the medusa-buds are set free during the summer.

Allman gives a good description of the hydroid.

### Steenstrupia aurata.

*Euphysa aurata*, (medusa) Forbes, 1848, British Naked-eyed Medusæ, p. 71, plate 13, fig. 3.
*Euphysa aurata* (medusa)+*E. mediterranea*, Haeckel, 1879, Syst. der Medusen, p. 32, taf. 2, figs. 8, 9.
*Euphysa mediterranea*, du Plessis, 1888, Recueil Zool. Suisse, tome 4, p. 543.
*Euphysa aurata* (Forbes), Browne, 1895, Trans. Liverpool Biol. Soc., vol. 9, p. 248; 1896, Proc. Zool. Soc. London, p. 474.
*Euphysa aurata*, Browne, 1905, Proc. Roy. Soc. Edinburgh, vol. 25, p. 749.—Bedot, 1905, Revue Suisse de Zool., tome 13, p. 134.
*Corymorpha nana*, (hydroid) Alder, 1857, Cat. Zooph. Northumberland and Durham, p. 111, plate 7, figs. 7, 8.—Hincks, 1868, Hist. British Hydroid Zooph., p. 130, plate 22, fig. 3.
*Corymorpha nana*, Hartlaub, 1907, Nordisches Plankton, Nr. 12, p. 81, figs. 76–78 (list of authors and localities).
(?) *Euphysa virgulata*, Agassiz, A., 1865, North Amer. Acal., p. 189, figs. 316–319.

This medusa is found off the Atlantic coasts of western Europe and in the Mediterranean. *Steenstrupia virgulata* of Massachusetts Bay is probably identical with *S. aurata*. For description of the European form, see synoptic table of characters of the species of *Steenstrupia*. The European *S. aurata* appears to be smaller than the American *S. virgulata*.

### Steenstrupia virgulata = (?) S. aurata Forbes.

Plate 1, fig. 6.

(?) *Steenstrupia aurata*, Forbes, 1848, British Naked-eyed Medusæ, p. 71, plate 13, fig. 3.
*Euphysa virgulata*, Agassiz, A., 1865, North Amer. Acal., p. 189, figs. 316–319.—Haeckel, 1879, Syst. der Medusen, p. 33.—Nutting, 1901, Bull. U. S. Fish Comm., vol. 19, p. 370.—Hargitt, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 33.
*Corymorpha virgulata*, Hartlaub, 1907, Nordisches Plankton, Nr. 12, p. 84, fig. 79.

*Adult medusa.*—The bell is pyriform, with a broad, dome-shaped apex. It is 5 to 12 mm. in height, and 4.5 to 9 mm. in diameter. Surface of exumbrella smooth and without rows of nematocysts. There are 4 tentacles, one at the base of each radial-canal; 3 of these are mere rudimentary bulbs, but the fourth is large and conical. Its surface is thickly covered with nematocyst-cells of large size. There are 4 simple, straight radial-canals, and a slender, circular vessel. The velum is wide, with an indented, free edge. The manubrium is cylindrical without a peduncle, and extends about half the distance from the inner apex of the bell-cavity to the level of the velar opening. No apical, axial canal. The mouth is a simple, round opening without prominent lips. The genital products are contained within the ectoderm of the manubrium. Manubrium light-yellow. The entoderm of the radial-canals near the bases of the tentacles is intense pink, and the ectoderm of the tentacles is milky-white. This species was found by Dr. Alexander Agassiz, in Massachusetts Bay, at Nahant, and is recorded from Woods Hole, Massachusetts, by Nutting and Hargitt.

The figure here shown is reproduced by his kind permission from Dr. Alexander Agassiz's drawing of the medusa. There is no difference between this medusa and *S. aurata* of Europe except that the American form appears to be larger; but the hydroid of the American medusa is unknown, and until this is discovered it will be impossible to determine the identity of the American form.

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**Steenstrupia tetrabrachia.**

*Euphysa tetrabrachia*, BIGELOW, H. B., 1904, Bull. Mus. Comp. Zool. at Harvard College, vol. 39, p. 251, plate 1, fig. 1.
(?) *Euphysora bigelowi*, MAAS, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 7, taf. 1, figs. 1–3.

Bell 4 mm. high, 2.5 mm. wide. Pyriform, with solid apical projection. One long sparsely-ringed tentacle about 4 times as long as the bell is high. 3 other, smaller tentacles, each about one-third as long as the bell-height. These bear each about 3 rings of nematocysts, while the long tentacle bears about 6 such rings. Velum well developed. Manubrium large, spindle-shaped, with mouth projecting beyond the velar opening. Gonads on sides of stomach. Eggs arranged in 8 fairly distinct rows. Bell colorless. Gonads brownish-yellow. Manubrium pinkish. Tentacle-bulbs and rings on tentacles rose-pink. Suvadiva Atoll, Maldive Islands, Indian Ocean; in January.

This medusa is probably redescribed by Maas as *E. bigelowi*.

**Steenstrupia bigelowi.**

*Euphysora bigelowi*, MAAS, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 7, taf. 1, figs. 1–3; 1906, Revue Suisse de Zool., tome 14, p. 84, pl. 2, figs. 1, 2.—MÜLLER, 1908, Zeit. für wissen. Zool., Bd. 89, p. 59.
(?) *Euphysora tetrabrachia*, BIGELOW, 1904, Bull. Mus. Comp. Zool. at Harvard College, vol. 39, p. 251, plate 1, fig. 1.

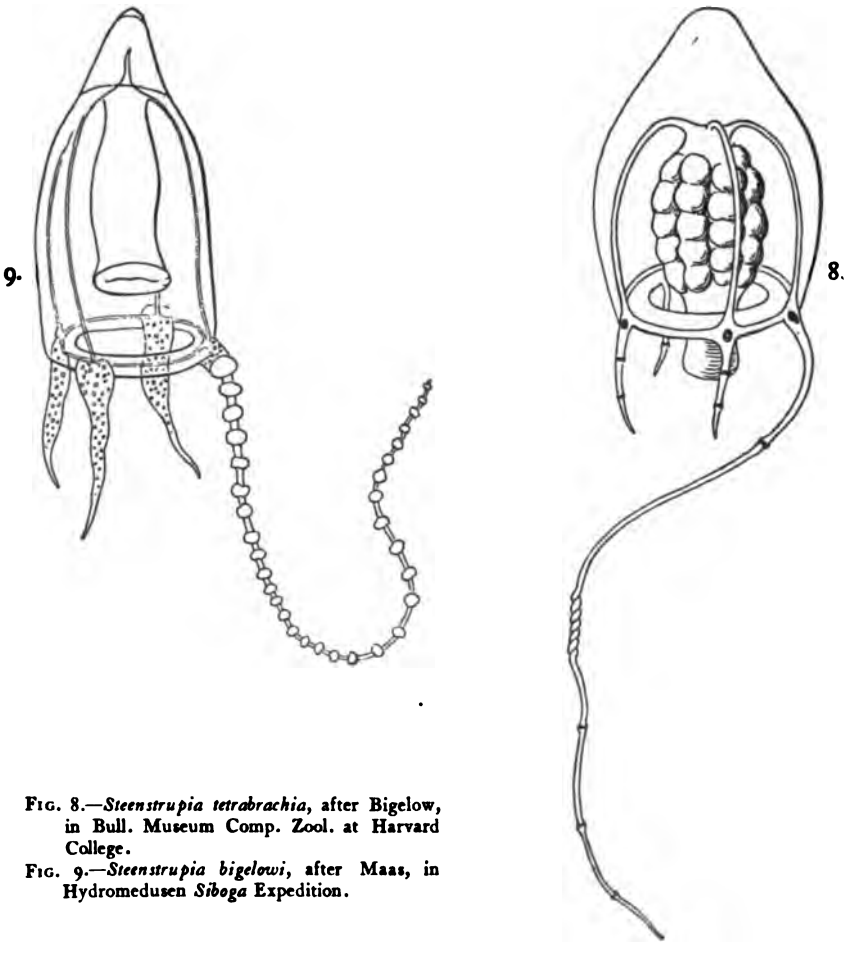


FIG. 8.—*Steenstrupia tetrabrachia*, after Bigelow, in Bull. Museum Comp. Zool. at Harvard College.
FIG. 9.—*Steenstrupia bigelowi*, after Maas, in Hydromedusen *Siboga* Expedition.

Bell 13 mm. high; more than twice as high as it is wide, and with a well-developed apical projection. Bell-cavity 10 mm. deep. Apical projection 3 mm. high. Side walls thin. 4 tentacles at the bases of the 4 radial-canals. One of these tentacles is longer than the bell-height and bears about 30 swollen nematocyst-warts. The 3 other tentacles are each one-third to half as high as the bell and are tapering, without nematocyst-warts, but covered with diffuse nettling cells. Manubrium spindle-shaped, not extending beyond the velar opening.

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In most specimens there is a blindly-ending axial canal extending into the gelatinous substance of the apical projection, but this is not constantly present. The gonads are developed upon the sides of the stomach, leaving only the basal and mouth ends of the manubrium free. A cross-section shows that they are separated by 4 minute, perradial, longitudinal lines. There are therefore 4 interradial gonads. There are no medusa-buds produced by the medusa.

The entoderm of the manubrium, radial-canals, and tentacle-bulbs is filled with yellow pigment granules. The nematocyst clusters on all 4 tentacles are red.

Found quite commonly in the Malay Archipelago, at Sulu, Ternate, Damar, Manifa, Saleyer, and Amboina.

This form differs from the closely allied *S. tetrabrachia* Bigelow, from the Maldive Islands, in that in the Maldive species there are a few rings of nematocysts upon the tentacles, whereas in *S. bigelowi* there are only warts, not inclosed rings. Also there appears to be no axial canal in *S. tetrabrachia*, whereas this is usually seen in *S. bigelowi*. The size constitutes a disparity in the two medusæ 4 mm. high in *S. tetrabrachia* and about 13 mm. in *S. bigelowi*. Future studies will probably show that these distinctions are not of specific value, but merely changes due to growth and variation, and that the two medusæ are identical and should be called *S. tetrabrachia*. "*Euphysa*" *tentaculata*, Linko, 1905 (Zool. Anzeiger, Bd. 28, p. 214), from Barents Sea has also 3 well-developed tentacles, and is 5 mm. high, with orange-colored manubrium and oval bell. It may be *Hybocodon pendula*.

### Steenstrupia australis.

*Euphysa australis*, VON LENDENFELD, 1884, Proc. Linnean Soc. New South Wales, vol. 9, p. 586, plate 21, fig. 33.

Bell is 2.5 mm. high, 1.7 mm. wide. Half-egg-shaped and symmetrical. No lines of nematocysts over the exumbrella. One very long retractile tentacle, 2 to 3 times as long as the bell-height. This tentacle has a large basal bulb, and is covered with rings of nematocysts. The other 3 tentacles are mere basal bulbs terminating in a knob-shaped cluster of nematocysts. Velum well developed. 4 straight radial-canals. Manubrium arises from the center of the umbrella cavity, and is cylindrical and about half as long as the bell-height. The gonad encircles the manubrium. Mouth deep violet. 4 brown patches upon the gonad, and a few brown spots on manubrium near its base. Tentacle-bulbs and the large tentacle brown with violet spots. Port Jackson, New South Wales, in May and June. Rare. Hydroid unknown.

## Genus HYBOCODON L. Agassiz, 1862.

*Hybocodon*, AGASSIZ, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 243.—AGASSIZ, A., 1865, North Amer. Acal., p. 193.—VANHÖFFEN, 1891, Zool. Anzeiger, Bd. 14, p. 443.—BROWNE, 1896, Proc. Zool. Soc. London, p. 466.—HARTLAUB, 1905, Zoolog. Jahrbüchern, Suppl. 6, p. 544; 1907, Nordisches Plankton, Nr. 12, p. 96.
*Hybocodon + Amphicodon*, HAECKEL, 1879, Syst. der Medusen, pp. 33, 35.
*Amphicodon*, BROWNE, 1902, Annals and Mag. Nat. Hist., ser. 7, vol. 9, p. 275.
*Diplura*, ALLMAN, 1871, Monog. Tubularian Hydroids, p. 326.
*Corymorpha*, AGASSIZ, A., 1865, *Ibid.*, p. 192.

This genus was established in 1862 by L. Agassiz for *Hybocodon prolifer*, a medusa which arises by budding from a *Corymorpha*-like hydroid on the New England coast. According to Browne, 1896, this medusa is also found off the northern coast of Europe. It is probable that the same medusa was described by Steenstrup, 1842, from Iceland, as *Corymorpha fritillaria*, but the hydroid from which Steenstrup supposed this medusa to be derived is certainly not *Hybocodon*, but may be an *Amalthæa* or *Diplura*. Steenstrup does not figure a basal circlet of tentacles upon the polypites, which have only an oral circlet, and below this a circlet of medusiform gonophores, each with a 4-sided bell, and 4 equally developed rudimentary tentacles. It is probable that the hydroids of *Hybocodon* differ more among themselves than do the medusæ, and no final classification of the medusæ can be attempted until all of the hydroids have been discovered.

### GENERIC CHARACTERS.

Codonidæ with asymmetrical bell. One of the 4 radial-canals is long, 1 short, and 2 of medium length. There are 1 or more long tentacles at the foot of the long radial-canal; and 3 small or rudimentary tentacles, 1 at the foot of each of the 3 other radial-canals. The hydroid is *Hybocodon*.

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Haeckel, 1874, instituted the genus *Amphicodon* to include medusæ with 3 rudimentary tentacles, and a cluster of 2 or more long tentacles at the foot of the longest radial-canal. Vanhöffen, 1891, Browne, 1896, and Hargitt, 1901, have pointed out, however, that the young medusæ commonly have but 1 long tentacle, and that others appear, and develop from the side of the basal bulbs of this original tentacle; thus the genus "*Amphicodon*" is only a mature *Hybocodon*. These secondary tentacles may appear before or after the medusa-buds begin to develop upon the tentacle-bulbs. According to Hargitt, 1902, 1904, Perkins, 1904, and Linko, 1905, the sexual products of the manubrium become mature while medusa-buds are still being produced upon the tentacle-bulbs.

*Synopsis of the Species of Hybocodon.**

| | H. prolifer L. Agassiz. | H. pendula Haeckel = Corymorpha pendula L. Agassiz. | H. forbesii Mayer. | H. unicus Browne. |
|---|---|---|---|---|
| Shape and size of bell in mm. | Dome-shaped. 2.5 high, 2.2 wide. 1 radial-canal long, 2 intermediate length, and 1 short. Long and short are 180° apart. | Quite similar to H. prolifer. 5 high, 3.5 wide. | Ellipsoidal, asymmetrical. 2.5 high, 2.1 wide. | Bell-shaped. 3 high, 2 wide. |
| Number of longitudinal lines of nematocysts on exumbrella. | 2 extend upward from base of well-developed tentacle, and 1 from base of each of 3 rudimentary tentacle-bulbs. | As in H. prolifer. | None. | ? |
| Condition of well-developed tentacle, or cluster of tentacles, at base of longest radial-canal. | 1 to 3 well-developed tentacles at base of longest radial-canal. Medusa-buds are produced at bases of these tentacles. Often only 1 well-developed tentacle produced. | Only 1 well-developed tentacle. No medusa-buds. | Only 1 well-developed tentacle. No medusa-buds. | Only 1 well-developed tentacle "between 2 rudimentary basal bulbs." No medusa-buds. |
| Condition of 3 rudimentary tentacles. | Mere basal bulbs. | 1 mere basal bulb. 2 small tentacles. Small tentacles 90° and basal bulb 180° from large tentacle. | 1 short conical tentacle. 2 mere basal bulbs. Short conical tentacle 180° and basal bulbs 90° from long tentacle. | 3 mere basal bulbs. |
| Gonads. | Developed over ectoderm of manubrium. Actinula larvæ develop upon surface of gonad in ectoderm of manubrium. | On ectodermal sides of manubrium. No actinulæ seen attached to gonad. | On manubrium. No actinulæ attached to gonad. | ? |
| Color. | Entoderm of tentacle-bulbs, radial-canals, and stomach orange to deep blood-red. | Pink granules in tentacle-bulbs. Entoderm of manubrium pink and lilac. | Entoderm of tentacles and manubrium yellow, flecked with red. | ? |
| Where found. | North Atlantic coasts of Europe, Iceland, and America. | Coast of New England, United States. | Bahama Islands, and Florida coast. Common in spring months, at surface. | Stanley Harbor, Falkland Islands. |
| Hydroid. | Hydroid described by L. Agassiz, 1862, as H. prolifer. | Hydroid is Hybocodon pendula = Corymorpha pendula L. Agassiz. | Unknown. | Hydroid may be H. chilensis Hartlaub, 1905. |

*For description of *H. chilensis* Hartlaub, *H. christinæ* Hartlaub, *H. pulcher* Hartlaub, and *H.* (?) *januarii*, see text.

## Hybocodon prolifer L. Agassiz.

Plate 2, fig. 1; plate 3, fig. 3.

(?) *Corymorpha fritillaria*, Steenstrup, 1842, Generations-wecksel., p. 20, taf. 1, figs. 41–46 (the medusa *only* may be identical with *H. prolifer;* the hydroid appears to be an *Amalthæa* or *Diplura*).
(?) *Steenstrupia globosa*, Sars, 1859, Christiania Vidensk. Selsk. Forhandl., p. 101.—Koren and Danielssen, 1877, in Sars's Fauna Littoralis Novegiæ, tome 3, p. 20, taf. 1, figs. 1–6.
(?) *Corymorpha annulicornis* (young medusa), Koren and Danielssen, 1877, *Ibid.*, p. 8, taf. 1, figs. 7–13.

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PLATE 2.

Fig. 1. *Hybocodon prolifer.* Woods Hole, Massachusetts, March 4, 1907. This drawing shows one of the normal aspects of the medusa, with the bell somewhat contracted. When the bell is extended the mouth comes to the level of the velar opening.

Fig. 2. *Hybocodon pendula.* Newport, Rhode Island, April 23, 1897.

Fig. 3. *Hybocodon forbesii.* Tortugas, Florida, June 26, 1906.

Fig. 4. *Dicodonium jeffersoni.* Tortugas, Florida.

Fig. 5. *Dicodonium floridana.* Tortugas, Florida, June 17, 1897.

Drawn from life, by the author.

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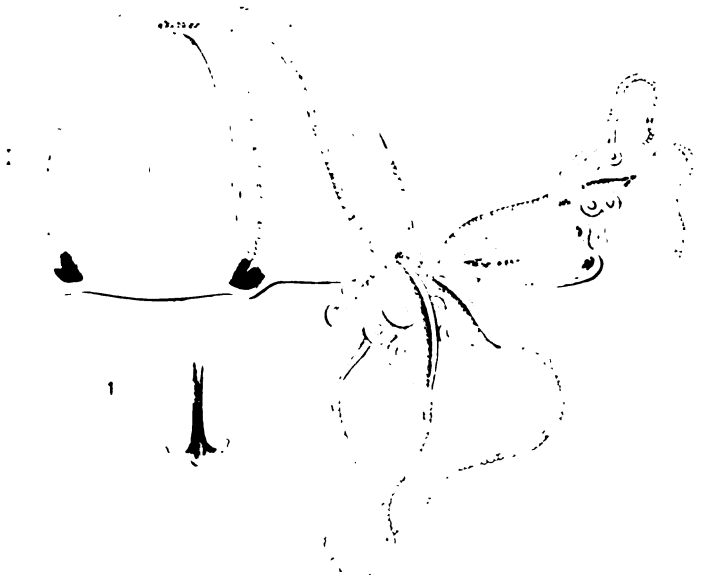

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*Hybocodon prolifer* (hydroid and medusa), AGASSIZ, L., 1862, Cont. Nat. Hist. U. S., vol. 4, pp. 243, 343, plate 23*a*, figs. 10, 11; plate 25, 19 figs.

*Hybocodon prolifer*, AGASSIZ, A., 1865, North Amer. Acal., p. 193, figs. 325–328.—ALLMAN, 1871, Monog. Tubul. Hydroids, p. 422.—VERRILL, 1873, Invert. Animals, Vineyard Sound, p. 736, plate 38, fig. 282.—BOHM, 1878, Jena. Zeitschr. für Naturw., Bd. 12, p. 195, taf. 7, figs. 7–9.—NUTTING, 1901, Bull. U. S. Fish Commission, vol. 19, p. 341, fig. 76.—HARGITT, 1904, Bulletin Bureau of Fisheries U. S., vol. 24, p. 33, plate 2, fig. 2; 1901, American Naturalist, vol. 35, p. 580, fig. 39; *Ibid.*, 1902, vol. 36, p. 552; 1901, Biol. Bulletin Woods Hole, vol. 2, p. 222.—PERKINS, 1904, American Naturalist 38, p. 516 (simultaneous sexual and asexual reproduction).

(?) *Hybocodon prolifer*, BROWNE, 1896, Proc. Zool. Soc. London, p. 466.

*Hybocodon prolifer* + *H. annulicornis* + ? *Amphicodon fritillaria* + ? *A. globosus* + *A. amphipleurus*, HAECKEL, 1879, Syst. der Medusen, pp. 33, 35, 36, 37, taf. 1, figs. 7–9.

(?) *Amphicodon fritillaria*, BROWNE, 1895, Trans. Liverpool Biol. Soc., vol. 9.

(?) *Amphicodon gravidum*, LINKO, 1905, Zool. Anzeiger, Bd. 28, p. 215 (simultaneous sexual and asexual reproduction).

(?) *Hybocodon prolifer*, BROWNE, 1905, Proc. Roy. Soc. Edinburgh, vol. 25, p. 752.

*Non Hybocodon prolifer*, BONNEVIE, 1899, The Norwegian North Atlantic Expedition, 1876–1878, vol. 26, Hydroida, p. 28, plate 1, fig. 6.

*Hybocodon prolifer*, HARTLAUB, 1907, Nordisches Plankton, Nr. 12, p. 98, figs. 94–97.—MÜLLER, H., 1908, Zeit. für wissen. Zool., Bd. 89, pp. 62, 73 (origin and structure of the eggs).

(?) *Hybocodon gravidum* + *H. islandicus* + *H. amphipleurus*, HARTLAUB, 1907, Nordisches Plankton, Nr. 12, pp. 104, 106, figs. 99, 100.

The following description is derived from studies made of medusæ from the southern coast of New England, United States:

*Adult medusa.*—Bell about 2.5 mm. high and 2.2 mm. wide. It is asymmetrical, the side bearing long tentacles being longer than the other sides; or as Browne aptly describes it, the margin is not at right angles to the longitudinal axis of the bell, but slopes toward the side bearing the cluster of long tentacles. The 4 radial-canals are of lengths corresponding to the sides of the bell. The canal leading to the cluster of long tentacles is the longest; while the canal diametrically opposite to this is the shortest, the 2 other canals being of intermediate length. There are 3 small, rudimentary tentacle-bulbs, 1 at the foot of the shortest canal, and 1 at the foot of each of the intermediate canals. The cluster of tentacles at the foot of the long radial-canal has wide, hollow, tapering basal bulbs. The main shaft of each tentacle is, however, slender, cylindrical, and contractile, and is annulated at regular intervals by well-developed clusters of nematocysts. Young medusæ commonly have but a single long tentacle, but as growth proceeds they sometimes develop another and finally a third; and all 3 grow to be of equal length, and form a conspicuous cluster. A number of medusa-buds in various stages of development arise from the sides of the hollow base of the one or more long tentacles, near the bell-margin. These medusa-buds themselves develop a single long asymmetrical tentacle even before the bud is mature. When ready to be set free they resemble the parent medusa in that they are sometimes observed to be developing a third generation of medusæ upon their tentacle-bulbs. 5 longitudinal lines of nematocyst-cells extend from the bases of the tentacles to near the apex of the bell. 3 of these rows arise from the bases of the 3 rudimentary tentacles, and extend up over the surface of the exumbrella immediately over the radial-canals. In addition to these there are 2 rows which start from the base of the well-developed tentacles, and extend upward over the exumbrella surface on both sides of the long radial-canal. The velum is well developed. The radial-canals are narrow and straight. The manubrium is a simple tube, which usually extends about two-thirds the distance from the inner apex of the bell-cavity to the velar opening. The mouth has 4 short lips with their edges surrounded by nematocysts. The mature eggs are found in the ectoderm of the stomach, and there they develop into actinula larvæ before being set free. The entoderm of the tentacle-bulbs is intense orange. The rows of nematocysts upon the exumbrella often display an orange tinge, as does also the entoderm of the stomach.

*Hydroid.*—The hydroid was found in Massachusetts Bay, growing in tide-pools where the water was very pure. Stems about 50 mm. in height. They grow singly, or in small clusters, and do not branch. Each stem terminates distally in a single large polypite. The stems are not more than 1 mm. in diameter at the base, gradually enlarging toward upper end, and are about 3 mm. in diameter at base of polypite. They are covered with a delicate sheath of chitinous perisarc, which widens and displays several well-developed annulations near the base of the polypite. The polypite is flask-shaped with a very broad base; the mouth is situated at the extremity of a narrow cylindrical neck, which is capable of much distension. There are 2 oral verticils, each composed of about 16 tentacles. The tentacles of the row

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near the mouth are only about half as long as those of the lower circlet. In addition to these there are about 25 long, tapering, hollow tentacles in a zone surrounding the base of the polypite. During the breeding season, which occurs from January until May, great numbers of medusæ are developed upon the sides of the polypite immediately above the circlet of basal tentacles. The budding medusæ arise singly from the sides of the polypite and are not produced in clusters upon peduncles as in *Hybocodon christinæ*, *H. chilensis*, and *H. pulcher*. Longitudinal bands of orange pigment extend up the stem of the hydroid. The entoderm

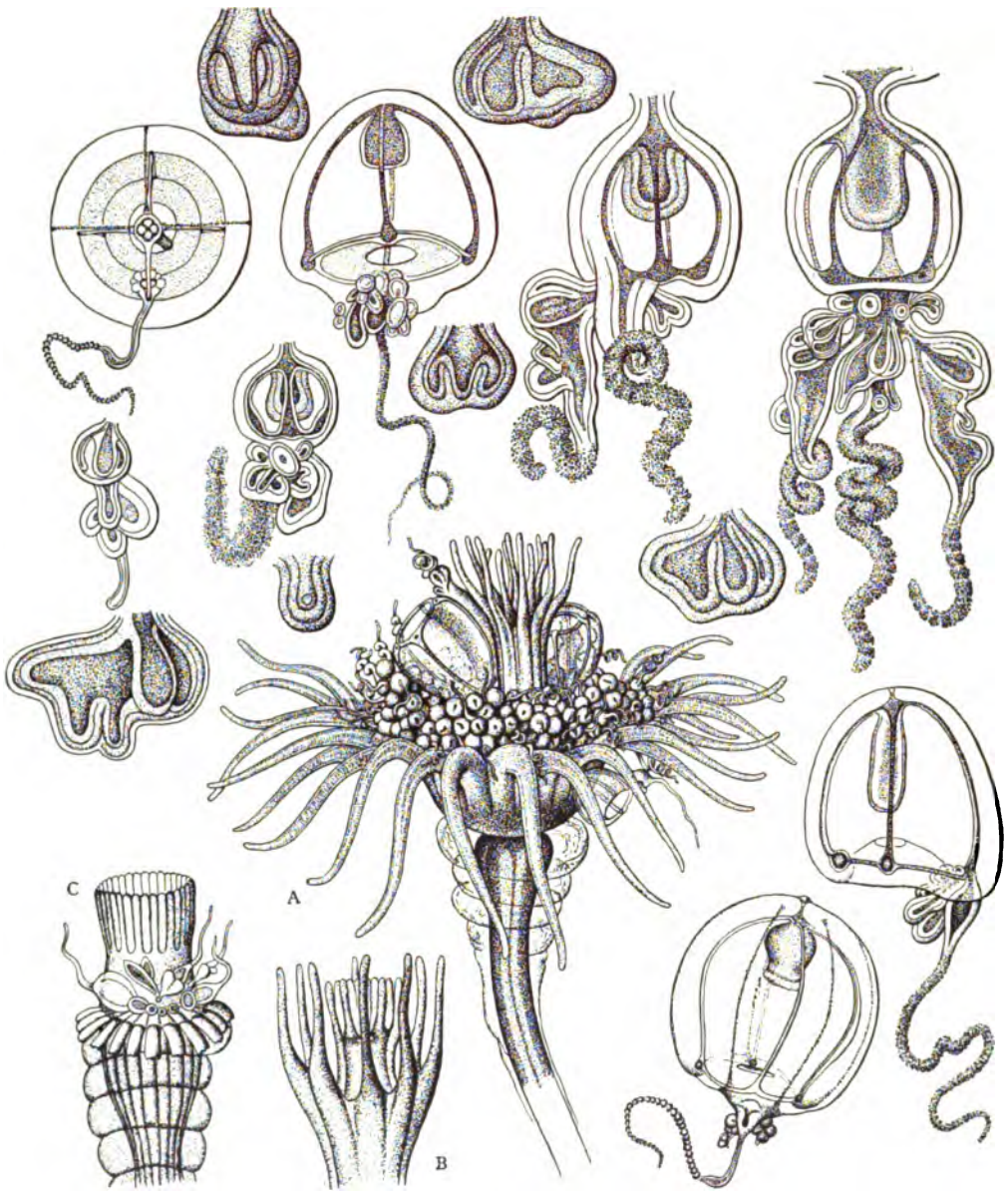


FIG. 10.—Hydroid, young, and budding medusæ of *Hybocodon prolifer*, after L. Agassiz, in Con. Nat. Hist. U. S., vol. 4. (*A.*) Mature hydranth. (*B.*) Oral extremity of hydranth. (*C.*) Dissection showing intertentacular zone of medusa-buds. Remaining figures are of medusa-buds and young medusæ.

of the polypite is orange. L. Agassiz has shown that the entoderm of the stem is thrown into longitudinal ridges which form partial septa projecting into the cavity of the stem. The cavity, however, is continuous, and the septa do not fuse as in some other Hyboconidæ.

This species is found upon the New England coast. According to Browne, 1896, it is found upon the British, and also on the Irish coast, at Valencia, and off Iceland (Steen-

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strup) and Norway (Sars). It is apparently widely distributed over the North Atlantic, along the shores of continents and islands. It is rarely taken far from some coast. We can not be certain that the American and European forms are identical until the hydroids of both are discovered.

Hargitt, 1904, states that the egg-cleavage is closely similar to that of *Pennaria*. Also Browne, 1895, and Hargitt, 1902, 1904, find that the ova begin their development within the walls of the manubrium of the medusa and are set free as actinulæ. Müller, 1908, and Hargitt, 1904, find that the developing embryos within the walls of the manubrium absorb their fellow ova, as has been observed by Doflein in *Tubularia mesembryanthemum*, and by Allen in *T. crocea*. Developing actinulæ and budding medusæ are abundant at Woods Hole, Massachusetts, during the spring months.

Hargitt, 1902, and Perkins, 1904, find that actinula larvæ develop upon the manubrium at the same time that medusa-buds are being set free from the tentacle-bulbs. When set free the actinulæ have 10 tentacles. The mouth and oral zone of tentacles develop only after the actinula is set free; and appear at the pole which was adjacent to the parent medusa during the attached period. Linko, 1905, also observed this simultaneous process of development of medusa-buds and of actinula larvæ in his "*Amphicodon gravidum*," which develops actinulæ with 11 tentacles. It is probably identical with *H. prolifer*. A single specimen was found in Barents Sea, north Russia.

H. Müller, 1908, finds that the ova are large and amœboid. Only about 2 eggs survive to maturity in the ovary; the others having been devoured by the successful eggs. The ooplasma is a network, the exoplasma being narrow-meshed and the endoplasma wider. There are numerous pseudo-cells in degenerate stages, sometimes dividing amitotically.

### Hybocodon pendula Haeckel.

Plate 2, fig. 2.

*Corymorpha nutans* (hydroid), Stimpson, 1853, Marine Invert. Grand Manan, p. 9.
*Corymorpha pendula* (hydroid), Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, pp. 276, 343, plate 26, figs. 7–17.—Verrill, 1873, Invert. Anim., Vineyard Sound, pp. 510, 736, plate 36, fig. 273.
*Corymorpha pendula*, Hartlaub, 1907, Nordisches Plankton, Nr. 12, p. 85, fig. 81.—Nutting, 1901, Bull. U. S. Fish Commission, vol. 19, pp. 337, 370, fig. 15.—May, 1903, American Naturalist, vol. 37, p. 579, 12 figs. (histology and embryology).
*Corymorpha pendula* (medusa), Agassiz, A., 1865, North Amer. Acal., p. 192, fig. 324.
*Hybocodon pendula*, Hargitt, 1904, Bulletin Bureau of Fisheries U. S., vol. 24, p. 34, plate 2, fig. 3.
*Hybocodon pendulus* (medusa), Haeckel, 1879, Syst. der Medusen, p. 34.
*Monocaulus pendulus*, Allman, 1871, Monograph Tubularian Hydroids, p. 397.

*Adult medusa*.—Bell pyriform and about 5 mm. in height. It is relatively higher than the bell of *H. prolifer*, and the gelatinous substance at the apex is much thicker. There are 5 rows of nematocysts upon the exumbrella, as in *H. prolifer*. The basal bulb of the well-developed tentacle is much smaller than in *H. prolifer*, and no medusa-buds have been observed to arise from it. The well-developed tentacle is 2 to 3 times the length of the bell-height. Its surface is studded with large, swollen rings of nematocysts, which give it a heavy appearance. The tentacles at the bases of the 2 intermediate radial-canals are quite well developed, and this is not the case in *H. prolifer*. The velum is wide and thin. The radial-canals are narrow and straight. The manubrium is longer than in *H. prolifer*, and extends a short distance beyond the velar opening. There is a small peduncle. The lips are thickly covered with nematocysts. Pink pigment-granules are found in the entoderm of the tentacle-bulbs. The entoderm of the manubrium is pink and lilac, and contains also some pink pigment-granules.

*Hydroid*.—The hydroid (*Corymorpha* [*Hybocodon*] *pendula*) is found in depths of 10 to 100 fathoms off the New England coast, with its base buried in the sand. It is 80 to 125 mm. in height, and 6 mm. in diameter at the widest part. It always grows singly and is never branched. The mid-region of the stem is very thick and is covered with a canaliculated cœnosarc, but the basal end narrows considerably, as does also the region near the free upper extremity, which is long, slender, and pendulous. The stem is anchored by a number of root-like, tubular, fleshy processes. The perisarc exists only as a thin delicate film. The head of the polypite is large and highly contractile. There is a single verticil of long, hollow tentacles at base of polypite. The mouth is situated at the extremity of a large flask-shaped proboscis,

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and is surrounded by a couple of rows of numerous irregularly arranged tentacles. These oral tentacles are highly contractile, and are much smaller than those at the lower base of the polypite. The medusæ are borne upon branched stolon-like diverticula of the side walls of the polypite, immediately above the zone of basal tentacles. Fully-developed medusæ have not been seen to be set free from the hydroid, but the similarity of the most advanced medusa-buds observed to the free medusa found in the ocean leaves but little doubt concerning this point. May, 1903, has studied the histology and embryology, and concludes that the medusa-buds may at times become free, but usually mature while still attached to the hydranth. This species has been found from Vineyard Sound to the mouth of the St. Lawrence River. The medusa appears upon the southern New England coast in April and May, but is not seen during the summer months, although the hydroid is abundant at this time.

It is possible that *Euphysa tentaculata* Linko, 1905, is identical with *H. pendula* (see Zool. Anzeiger, Bd. 28, p. 214). Linko's medusa is from Barents Sea, north of Russia. I have referred to this medusa in the description of *Steenstrupia bigelowi*.

### Hybocodon forbesii Mayer.

Plate 1, fig. 8; plate 2, fig. 3.

*Hybocodon forbesii*, MAYER, 1894, Bull. Mus. Comp. Zool. at Harvard College, vol. 25, No. 11, p. 236, plate 1, fig. 1; 1904, Memoirs Nat. Sci. Museum Brooklyn Institute, vol. 1, No. 1, p. 8, plate 2, fig. 13.

*Medusa.*—Bell asymmetrical, about 2.5 mm. in height and ellipsoidal in shape, being slightly higher than broad. The gelatinous substance is of uniform thinness. There is a single well-developed tentacle situated at the base of the longest radial-canal. A short, conical tentacle is found at the base of the shortest radial-canal, and two smaller tentacle-bulbs are situated one at the base of each of the intermediate canals. The well-developed tentacle is about as long as the bell-diameter. Its base is small, and hardly greater in diameter than the shaft of the tentacle. Its free extremity is fusiform, and covered with prominent nematocyst-cells. No medusa-buds have ever been observed. The velum is narrow. The 4 radial-canals are straight and slender and the circular canal is narrow. There are no rows or clusters of nematocysts upon the exumbrella. Manubrium is spindle-shaped and swollen, and the mouth is a simple, round opening situated at the extremity of a narrow tubular neck, which extends beyond the velar opening. The entoderm of the terminal swelling of the large tentacle is yellow streaked with red. Entoderm of manubrium yellow with red flecks.

This species is found in Nassau Harbor, New Providence Island, Bahamas, and at Tortugas, Florida, in March to May. It is an abundant surface form. I have captured many hundreds of specimens, but have never found them producing either medusa-buds or actinula larvæ. It is distinguished by its decided yellow and orange color, and the absence of meridional lines of nettle-cells over the exumbrella.

### "Hybocodon unicus."

*Amphicodon unicus*, BROWNE, 1902, Annals and Mag. Nat. Hist., ser. 7, vol. 9, p. 276.
(?) *Hybocodon chilensis* (hydroid), HARTLAUB, 1905, Zoolog. Jahrbüchern, Suppl. 6, p. 545, fig. W.

Bell 3 mm. high, 2 mm. wide, bell-shaped. 1 solitary tentacle between 2 rudimentary basal bulbs; 3 perradially situated bulbs without tentacles. Medusa-buds (?) Manubrium cylindrical, nearly as long as the umbrella cavity. Color (?) Asymmetry of bell (?) One specimen was found by Vallentin, and briefly mentioned without figures by Browne, from Stanley Harbor, Falkland Islands. *Hybocodon chilensis* Hartlaub, from the coast of Chile, may prove to be the hydroid of this medusa (?) It will be impossible to identify the medusa from the brief mention of it given by Browne, unless, indeed, it be rediscovered in Stanley Harbor.

### Hybocodon chilensis Hartlaub.

*Hybocodon chilensis*, HARTLAUB, 1905, Zoolog. Jahrbüchern, Suppl. 6, p. 545, fig. W.
(?) *Amphicodon unicus* (medusa), BROWNE, 1902, Annals and Mag. Nat. Hist., ser. 7, vol. 9, p. 276.
(?) *Steenstrupia occidentalis* (medusa), FEWKES, 1889, Bulletin Essex Institute, Salem, vol. 21, No. 7, p. 107, plate 3, fig. 1.
*Hybocodon occidentalis*, HARTLAUB, 1905, Zoolog. Jahrbüchern, Suppl. 6, p. 545.

As Hartlaub states, this hydroid may be the stock of *Amphicodon* (*Hybocodon*) *unicus* Browne, from the Falkland Islands.

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The hydrocaulus is very thick and massive, about 50 mm. long and unbranched save for the presence of its roots and stolons. It is covered with a stiff layer of chitin, which is not expanded at the base of the polypite. Polypite large, with 17 to 20 proximal tentacles, each about 6 mm. long. There are also about 27 oral tentacles arranged in several rows. Above the bases of the proximal tentacles there are 8 long, thick, medusa-bearing stolons, which are thickly covered with numerous clusters of medusa-buds. Each medusa-bud has a single very large tentacle. The stem of the hydroid is rusty yellow and the polypite light rose-color. Found at Calbuco, Chile, South America.

This *Hybocodon* is closely related to, or possibly identical with, the form from Norway described by Bonnevie under the name *Hybocodon prolifer*, but it differs from *H. prolifer* Agassiz in having large, specialized, medusa-bearing stolons. Hartlaub proposes to call this Norwegian hydroid *Hybocodon christinæ*.

Fewkes, 1889 (Bull. Essex Inst., and also Amer. Naturalist, vol. 32, p. 597), gives a brief description of a medusa from the coast of California which he calls by two names, *Steenstrupia occidentalis* and *S. californica;* and which may be derived from *Hybocodon chilensis*. This medusa is described as follows: Size (?) Bell ovoid without an apical prominence. 4 (?) 5 (?) rows of meridional lasso-cells extend upward from the 4 tentacle-bulbs, over the exumbrella toward the bell-apex. 1 long tentacle and 3 rudimentary tentacle-bulbs at the bases of the 4 radial-canals. The long tentacle is ringed at regular intervals and has a large pigmented basal bulb from which there arise numerous medusa-buds. Color (?) Velum well developed. 4 straight, narrow radial-canals. Manubrium shorter than the depth of the bell-cavity. No axial canal. Coast of California, United States.

Hartlaub proposes to call this medusa *Hybocodon occidentalis*. I find nothing in Fewkes's description to distinguish it from *H. prolifer* L. Agassiz, but apparently there is less difference between the medusæ of the various forms of *Hybocodon* than between their hydroids.

### Hybocodon christinæ Hartlaub.

*Tubularia prolifer = Hybocodon prolifer*, Bonnevie, 1899, The Norwegian North Atlantic Expedition, 1876–79, vol. 26, Hydroida, p. 28, plate 1, fig. 6.
*Hybocodon christinæ*, Hartlaub, 1905, Zoolog. Jahrbüchern, Suppl. 6, p. 546; 1907, Nordisches Plankton, Nr. 12, p. 102, fig. 98.

The medusa attributed by Bonnevie to this hydroid has a single well-developed tentacle with a basal cluster of large medusa-buds, each bud bearing a single tentacle. The medusa-buds resemble *H. prolifer*, but the hydroid is distinguished by bearing its medusæ upon 8 branched peduncles.

Hydrocaulus unramified, tubular, springing from a ramified hydrorhiza; occurrence solitary; longitudinal striping, no collar; height about 50 mm. The hydranth has 14 proximal tentacles and 2 distinct circles of (oral) distal tentacles. The oral tentacles are shorter and more numerous than the proximal. There are 8 blastostyles in a circle about midway between the oral and basal tentacles, and these bear numerous medusæ upon short pedicels. The medusa-buds have 4 very wide radial-canals, and 1 highly developed tentacle which exhibits at its swollen base the bud-rudiments of 4 new medusæ even before the first has become detached. This species is distinguished by its well-developed, branched, medusa-bearing stolons. Found off Bodö, Norway. It is closely related to *H. chilensis* Hartlaub, of the northern coast of Chile.

The medusa-buds in *H. christinæ* appear to be confined to the under side and the sides of the base of the well-developed tentacle.

Hartlaub, 1907, finds that the medusa becomes 4 mm. high and 3 mm. wide, with thin bell-walls and an evenly rounded apex. The 4 radial-canals and ring-canal are band-like, and wider than in other species of *Hybocodon*.

### Hybocodon pulcher Hartlaub.

*Auliscus pulcher*, Samundsson, 1899, Vid. Meddel. Nat. For. Kjöbenhavn, Ser. 6, Aarg. 1, p. 425, taf. 4, 7 figs.
*Hybocodon pulcher*, Hartlaub, 1905, Zool. Jahrbüchern, Suppl. 6, p. 545; 1907, Nordisches Plankton, Nr. 12, p. 96, figs. 92, 93.

Hydroid 40 to 50 mm. high with an oral circlet of 30 short tentacles, and another circlet of 24 to 30 long tentacles around widest part of body of the hydranth. The only distinctive characters of this species are the well-developed medusa-bearing stolons, the symmetrical

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bell, and 2 large principal tentacles of the budding medusa. In *H. prolifer*, on the other hand, the medusæ are usually set free with but *one* well-developed tentacle. The bell of *H. pulcher* may become asymmetrical in later life (?) The hydrorhiza is thin and branching. There is a flexible collar-like perisarc at the base of the hydranth. Medusæ are developed upon stolons from the hydranth above the circlet of long tentacles. When set free the medusa is 1.5 to 2 mm. high, of symmetrical form. 5 longitudinal lines of nematocysts extend up the sides of the bell to the apex. 3 small tentacle-bulbs. 2 equally well-developed tentacles arise side by side, from the base of one of the radial-canals. Entoderm of manubrium and tentacles red. Found off Iceland. I believe this form is probably identical with *H. prolifer*.

### Genus MICROCAMPANA Fewkes, 1889.

*Microcampana*, FEWKES, 1889, Amer. Naturalist, vol. 32, p. 595; Bull. Essex Inst., Salem, vol. 21, No. 7, p. 111.

The type-species is *Microcampana conica* Fewkes, from Santa Cruz Island, off the coast of California.

GENERIC CHARACTERS.

Anthomedusæ with 6 radial-canals, and 6 radially placed marginal tentacles. One of these tentacles is well developed, and the other 5 are rudimentary.

It is possible that the vaguely described *Rhabdoon singulare*, of Keferstein und Ehlers, (1861, Zoolog. Beiträge, p. 86, taf. 13, figs. 6, 7), from Messina, Mediterranean, is a form of *Microcampana*, but there are apparently 12 longitudinal lines of nettling cells over the exumbrella, and it is uncertain whether there are 4 or 6 radial-canals. The bell is 1.5 mm. high and oval with uniformly thin walls. It is possibly an abnormal medusa of *Velella*.

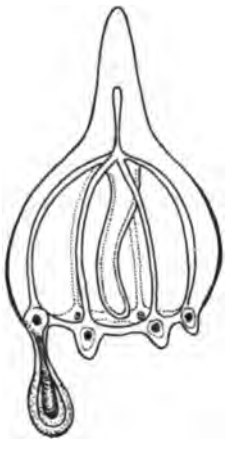

FIG. 11. — *Microcampana* after Fewkes in American Naturalist.

#### Microcampana conica Fewkes.

*Microcampana conica*, FEWKES, 1889, Bull. Essex Inst., Salem, vol. 21, No. 7, p. 111, plate 4, fig. 8; American Naturalist, vol. 32, p. 595, fig.

Size (?) Bell conical with a well-developed, elongate, conical apex; slightly asymmetrical. Exumbrella smooth, without meridional rows of nematocysts. 6 marginal tentacles, 60° apart. 5 of these are rudimentary, but the sixth is club-shaped, and about half as long as the bell-height. 6 straight, narrow radial-canals and a ring-canal. Manubrium conical to spindle-shaped, about as long as the depth of the bell-cavity. There is a long, slender, straight, axial canal above the stomach. Bell pink, tentacle-bulbs bright-red, manubrium yellow. Found off Santa Cruz Island, California; under the cliffs of Punta Diablo.

### Genus DICODONIUM Haeckel, 1879, sens. ampl.

*Dicodonium+Dinema*, HAECKEL, 1879, Syst. der Medusen, pp. 27, 28.
*Non Dinema*, VAN BENEDEN, 1867, Mém. Acad. Roy. des Sci. Belgique, tom. 36, art. 2, pp. 127, 130.
*Dicodonium*, VANHÖFFEN, 1891, Zool. Anzeiger, Bd. 14, p. 443.
*Sarsiella*, HARTLAUB, 1907, Nordisches Plankton, Nr. 12, p. 66.

The type-species of this genus is *Dicodonium cornutum* Haeckel, 1879, of the Red Sea. *Dinema* Van Beneden is a medusa which arises by budding from a *Perigonimus*-like hydroid and therefore belongs to the Tiarinæ. We use the term *Dicodonium* in the sense proposed by Vanhöffen, 1891.

GENERIC CHARACTERS.

Codonidæ with 2 well-developed and 2 rudimentary tentacles. No meridional lines of nettle-cells upon the exumbrella. An apical projection to the bell and an axial canal projecting upward from the stomach, may or may not be present.

Some of the so-called "species" of *Dicodonium* are probably only abnormal specimens of *Sarsia* with 2 tentacles instead of the normal 4.

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## Plate 3.

Fig. 1. *Dicodonium jeffersoni*. Tortugas, Florida, June 15, 1897.

Fig. 2. *Sarsia mirabilis*, young medusa. Nahant, Massachusetts, March 26, 1897.

Fig. 3. *Hybocodon prolifer*. *t'*, primary; *t''*, secondary tentacle beginning to develop; *m*, young medusa-buds. Agassiz Laboratory, Newport, Rhode Island, September 17, 1895.

Fig. 4. *Sarsia mirabilis*, mature male. Nahant, Massachusetts, May 7, 1897.

Fig. 5. Hydroid of *Sarsia mirabilis* with ripe male medusa-bud attached to the hydranth. Swallows Cave, Nahant, Massachusetts, May 8, 1897.

Drawn from life, by the author.

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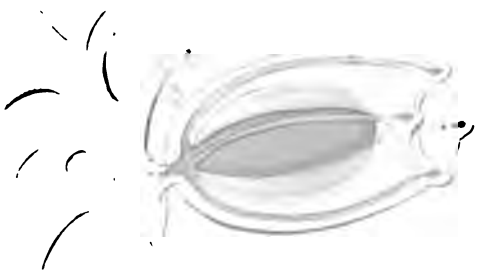

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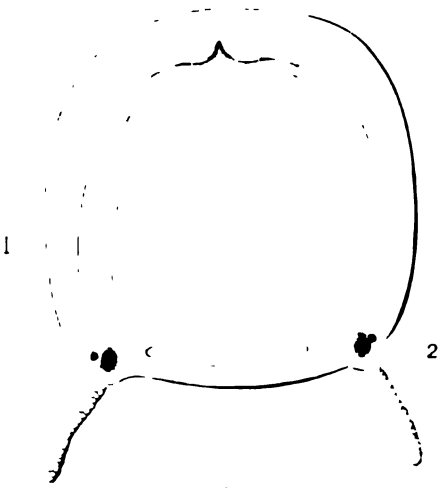

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*Tabular Description of the Medusæ of Dicodonium.*

| | D. cornutum Haeckel. | D. dissonema Haeckel. | D. ocellatum = Dinema ocellatum Haeckel. | D. floridana Mayer. | D. jeffersoni Mayer. | D. adriaticum Graeffe. | D. dinema = Sarsiella dinema Hartlaub. |
|---|---|---|---|---|---|---|---|
| Shape and size of bell in mm. | With bulging sides, and pointed apex. 4 high, 4 wide. | Bell-shaped to egg-shaped with blunt conical apex. | Bell-shaped to hemispherical. 5 high, 4 to 5 wide. Exumbrella besprinkled with tufts of nettle-cells. | Cylindrical with dome-like apex. 4 high, 3 wide. | Dome-like 0.75 high, 0.5 wide. | Bell-shaped with a small, conical, apical projection. 4 high, 3.5 wide. | Half-egg-shaped. 3 high, 2 wide. |
| Length of 2 long tentacles in terms of bell-radius (*r*). | Curled upward. 3 *r* long. A row of bristling clusters of nettle-cells on their abaxial sides. Tips club-shaped. Basal bulbs small. | 6 *r* ± long. Very large basal bulbs and with an abaxial ocellus. | 2 *r* long, with fairly large tentacle-bulbs, each with an abaxial ocellus. | 2 *r* long with a knob-like swelling near tip. Extreme tip ends in thin lash. No ocelli. | *r* long. Basal bulbs bear ocelli. | 8 *r* long. A large carmine ocellus on each tentacle-bulb. | 2 *r* + long. Basal bulbs small; with ocelli. |
| Condition of 2 rudimentary tentacle-bulbs. | Not present. | ? | Mere bulbs. | Small, tapering, rudimentary. | Mere basal bulbs with abaxial ocelli. | Mere basal bulbs with small carmine ocelli. | Absent. |
| Axial canal above stomach. | Well developed. | Present. | Not present. | Not present. | A small axial canal is present. | Not present. | |
| Shape of manubrium, and length in terms of bell-radius (*r*). | Spindle-shaped. 1.5 *r* long. Mouth a simple round opening surrounded by nettle-cells. | Spindle-shaped. 2 to 3 times as wide in middle as at either end. | Club-shaped. 5 to 7 *r* long. | Flask-shaped, widest above, but near middle. | Cylindrical, with a narrow tubular mouth-end. | Short, thick, and four-sided. | Spindle-shaped, 6 *r* long. |
| Gonad. | Ring-like, swollen, encircling middle third of manubrium. | Large swollen gonad encircles stomach. | Gonad encircles stomach, thickest near mouth. | Encircling stomach. | Large gonad encircles stomach from base to near mouth. | In stomach wall. | Encircles entire stomach. |
| Color | Stomach, tentacles, and nettle-ring of margin dark purple-red. | ? | Bell-margin rose-red. Nematocyst clusters of exumbrella black. Ocelli of tentacle-bulbs black. | Entoderm of stomach and tentacles yellow. Knob-like ends of tentacles flecked with red to orange. | Entoderm of stomach creamy pink; of tentacle-bulbs delicate green or pink. Ocelli red. | ? | Entoderm brownish-yellow. |
| Where found. | Red Sea, Gulf of Suez. | Coast of Australia. | Trieste, Adriatic Sea. | Tortugas, Florida. On surface in June to July, rare. | Tortugas, Fla. May to June, common. | Trieste, Adriatic Sea. | Normandy, coast of France. Mediterranean ? |
| Remarks. | Development unknown. | Development unknown. | Development unknown. Is this an abnormal Sarsia with only 2 tentacles ? | Development unknown. Occasionally rudimentary tentacles develop so as to be almost as long as the larger pair. | Development unknown. | Development unknown. This species is distinguished by stiff sensory hairs which border ocelli. | |

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### Dicodonium cornutum Haeckel.

*Dicodonium cornutum*, HAECKEL, 1879, Syst. der Medusen, p. 27, taf. 1, fig. 6.

Haeckel found this species at Tur, near Sinai, in the Red Sea. See tabular description of medusæ of *Dicodonium*. It has no ectodermal ocelli upon the bulbs of the 2 large tentacles. Haeckel presents a beautiful figure of the medusa, drawn from life.

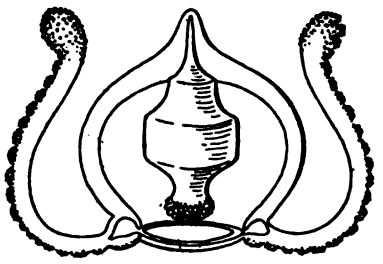

FIG. 12.—*Dicodonium cornutum*, after Haeckel, 1879.

### Dicodonium dissonema Haeckel.

*Dicodonium dissonema*, HAECKEL, 1879, Syst. der Medusen, p. 27.

Haeckel describes this from a preserved specimen from the coast of Australia. See tabular description of the medusæ of *Dicodonium*.

### "Dicodonium ocellatum."

*Sarsia ocellata*, BUSCH, 1851, Beobach. wirbellos. Seeth., p. 16, taf. 2, figs. 1–3.
*Dinema ocellatum*, HAECKEL, 1879, Syst. der Medusen, p. 29.

This medusa is described by Busch from Trieste, Adriatic, and it is probably an abnormal *Sarsia* with only 2 of its 4 marginal tentacles developed. See tabular description of the medusæ of *Dicodonium*.

### Dicodonium floridana Mayer.

Plate 2, fig. 5.

Bell about 4 mm. high and 3 mm. wide, with thin, uniform, vertical walls and a slight apical projection. There are 2 equally-developed, diametrically opposed tentacles, each about three-fourths as long as the bell-height. Near the outer end of each of these tentacles there is a large, knob-like, swollen region, which terminates in a thin, tapering, nematocyst-bearing lash. The knob-shaped swelling is hollow and its cavity is connected with the general gastrovascular system of the medusa by means of a slender tube which extends through the entodermal core of the tentacle. The basal bulbs of the tentacles are not large, and there are no ocelli.

In addition to the 2 long tentacles, there are 2 small, tapering, rudimentary tentacle-bulbs 90° from the large tentacles. The velum is well developed. There are 4 straight, narrow radial-canals and a simple, narrow circular canal. The manubrium is flask-shaped, being narrower at its base than at its middle point. The mouth projects slightly beyond the velar opening, and is a simple, round opening at the extremity of a long, tapering neck. The gonads are within the wall of the manubrium. The entoderm of the stomach is yellow, and that of the distal bulbs of the tentacles yellow flecked with orange. The entoderm of the basal bulbs of the tentacles is also tinged with yellow.

This medusa is occasionally found at Tortugas, Florida, in June. Occasionally a specimen is taken in which the normally rudimentary tentacles have developed so as to be nearly as long as the pair of large tentacles, thus illustrating the imperfect line of separation between *Dicodonium* and *Sarsia*.

### Dicodonium jeffersoni Mayer.

Plate 2, fig. 4; plate 3, fig. 1.

*Dinema jeffersoni*, MAYER, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 30, plate 37, fig. 126.

The bell is dome-shaped, higher than a hemisphere, and about 0.75 mm. high. The exumbrella surface is sparsely sprinkled with nematocysts. There are 2 short marginal tentacles, and 2 rudimentary tentacle-bulbs. The tentacles are radially situated, and are covered with numerous small wart-like clusters of nematocysts. There are 4 ectodermal ocelli, 1 upon the outer side of each of the 4 tentacle-bulbs. The velum is well developed. There are 4 straight, narrow radial-canals and a narrow circular vessel. The manubrium is about as long as the depth of the bell-cavity. It is simple, cylindrical, and tube-like, and the mouth is a round opening at the extremity of a short, cylindrical neck. A simple canal

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projects upward from the stomach into the gelatinous substance of the apex of the bell. This is probably only the remnant of the connection between the medusa and its hydroid stock. The gonad is ring-like, and encircles the stomach, leaving the short proboscis free.

The entoderm of the tentacles and tentacle-bulbs is of a delicate green or pink. The entoderm of the stomach is creamy pink. The ocelli are bright-red, and all other parts are colorless.

This medusa is quite common at the Tortugas, Florida, in May and early June. Although small, it appears to be mature, for sperm is often given off from the gonad of the males.

### Dicodonium adriaticum Graeffe.

*Dicodonium adriaticum*, GRAEFFE, 1884, Arbeit. Zool. Inst. Wien, Bd. 5, p. 351.

Bell 4 mm. high, 3.5 mm. wide, bell-shaped, with a small, conical, apical projection. 2 long, radially placed tentacles, more than 12 mm. long, with large, thick, basal bulbs, each with a large carmine ocellus upon the abaxial side of the bulb. 2 tentacle-bulbs at the bases of the 2 radial-canals 90° away from the large tentacles. These basal bulbs have small red ocelli. Each of these 4 ocelli are bordered by a ring of stiff sensory hairs. There are 4 small, interradial tentacle-bulbs without ocelli. Thus there are 2 long tentacles, and 6 rudimentary tentacle-bulbs. 4 radial-canals. Stomach short, thick, and 4-sided, with the gonads in the stomach-wall. Mouth simple, with 4 lips. Found at Trieste, Adriatic Sea, in October.

### Dicodonium dinema.

*Sarsiella dinema*, HARTLAUB, 1907, Nordisches Plankton, Nr. 12, p. 67, fig. 63.

Bell oval, half-egg-shaped, 3 mm. high, 2 mm. wide. Exumbrella thickly besprinkled with nematocysts. Only 2 tentacles, 180° apart. These are longer than the bell-diameter. They have small basal bulbs, each with a reddish-brown ocellus. No trace of tentacle-bulb or tentacles 90° apart from the well-developed tentacles. Manubrium about 2 times as long as the bell-height. Spindle-shaped and encircled throughout by the gonad. Manubrium, tentacles, and 4 radial-canals brownish-yellow. Found off the coast of Norway and in the Mediterranean (?) Is this an abnormal young *Sarsia* with only 2 tentacles? Hydroid unknown. Medusa rare.

## Genus SARSIA Lesson, 1843.

*Sarsia*, LESSON, 1843, Hist. Zooph. Acal., p. 333.—AGASSIZ, L., 1849, Mem. Amer. Acad., New Series, vol. 4, p. 224; 1862, Cont. Nat. Hist. U. S., vol. 4, p. 211.—WAGNER, 1885, Wirbellosen des Weissen Meeres, p. 76.—VANHÖFFEN, 1891, Zool. Anzeiger, Bd. 14, p. 442.—HARTLAUB, 1897, Hydromedusen Helgolands, p. 454; 1907, Nordisches Plankton, Nr. 12, p. 7.—VON LENDENFELD, 1884, Proc. Linnean Soc. New South Wales, vol. 9, p. 582.—CHUN, 1895, Bibliotheca Zoologica, Bd. 1, Heft. 19, p. 4.—GOETTE, 1904, Zool. Anzeiger, Jahrg. 27, p. 473.
*Coryne+Syndictyon*, AGASSIZ, A., 1865, North Amer. Acal., p. 175.
*Coryne* (hydroid), CALKINS, 1899, Proc. Boston Soc. Nat. Hist., vol. 28, p. 336.
*Codonium+Sarsia+Syndictyon*, HAECKEL, 1879, Syst. der Medusen, pp. 13, 16, 20.
*Syncoryne*, WEISMANN, 1883, Entsteh. Sexualzellen Hydromedusen, pp. 56, 216.
*Syncoryne* (hydroid), HARTLAUB, 1905, Zool. Jahrbüchern, Suppl. 6, p. 524.—NUTTING, 1901, Proc. Washington Acad. Sci., vol. 3, p. 165.
*Syncoryne* (medusa), HARGITT, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, pp. 29, 30.
*Syncoryne*, BEDOT, 1905, Revue Suisse de Zool., tome 13, p. 119 (citation of all references to 1850).
*Syndicton*, AGASSIZ, A., 1862, in L. Agassiz's Cont. Nat. Hist. U. S., vol. 4, p. 340.—MAYER, 1904, Mem. Nat. Sci. Museum Brooklyn Institute, vol. 1, p. 7.
*Steryo*, DUJARDIN, 1845, Annales Sci. Nat., ser. 3, tome 4, p. 257.

The type-species of this genus is *Sarsia tubulosa* of the northern coasts of Europe. This medusa was first described by Lesson, 1843. The hydroid form was first described by Gärtner, 1774, in Pallas's Eleunch. Zooph., under the name of *Coryne*. Ehrenberg, Sars, and Allman introduced the name *Syncoryne*. *Stauridia producta* also gives rise to a medusa which can not be distinguished from *Sarsia*.

### GENERIC CHARACTERS.

Codonidæ with 4 long, simple, equally developed tentacles, 1 at the foot of each radial-canal. The manubrium is tubular and surrounded by a ring-like gonad. There is an ectodermal ocellus upon the outer side of each tentacle-bulb. There are no meridional nematocyst-tracts upon the exumbrella.

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An apical projection of the bell may or may not be present; and there may or may not be an axial canal extending upward from the stomach into this projection. The hydroid is *Syncoryne* or *Stauridia*.

We use the name *Sarsia* in the sense defined by Vanhöffen, 1891 (Zool. Anzeiger, p. 442).

In 1862, 1865, A. Agassiz described, under the generic name *Syndictyon*, a *Sarsia* having reticulate nematocyst-cells upon its exumbrella, and clusters of such cells upon its tentacles. These are, however, only characters of immaturity and largely disappear in the full-grown medusa, which is a true *Sarsia* in all respects. In 1879, Haeckel formed the genus *Codonium* to include medusæ resembling *Sarsia* but distinguished by the possession of an apex upon the bell into which a blindly-ending axial canal extends from the stomach. A bell-apex and axial canal are characters which are acquired during growth in varying degrees by almost all species of *Sarsia*, and are therefore not of generic value.

Two European and one American species of *Sarsia* produce medusæ by asexual budding from the tentacle-bulbs or from the walls of the manubrium. Chun, 1895 (Bibliotheca Zoologica, Heft 19, fig. 2), showed that both ectoderm and entoderm of the manubrium take part in the formation of these proliferating medusæ; the entoderm of the manubrium forming the entoderm of the daughter medusa, and the same being true of the ectoderm. *Sarsia prolifera* Forbes, described and beautifully figured by Haeckel, 1879, under the name *Codonium codonophorum*, produces medusa-buds upon its tentacle-bulbs.

The majority of *Sarsia* medusæ are probably produced asexually by hydroids of the genus *Syncoryne*, but at least one medusa identical with *Sarsia* is derived from the hydroid called *Stauridia* Dujardin, 1843. Such medusæ may conveniently be placed in a subgenus *Stauridiosarsia*. A medusa which appears to be closely related to *Sarsia* is produced by the remarkable parasitic hydroid *Hydrichthys*.

The generic name *Syncoryne* was restricted by Allman, 1871–1872, to designate the hydroid which produces the medusa *Sarsia*. The name *Syncoryna* was first proposed by Ehrenberg, who applied it to hydroids now known as *Clava*, *Coryne*, etc., and in this old sense it does not apply exclusively to the hydroid of *Sarsia*. By general consent, Allman's name has been accepted in this restricted sense, Calkins, 1899, being almost alone in maintaining that the generic name of the hydroid should be *Coryne*.

The commonly accepted arrangement is to retain the old name *Coryne* to include hydroids in which the reproductive elements are produced in fixed sporosacs growing upon the hydranth, while *Syncoryne* applies to like hydroids which, however, produce free medusæ.

Weismann, 1883, found that the germ-cells of both sexes of *Syncoryne sarsii* originate in the ectoderm of the budding medusa, and do not wander from their place of origin, but become mature in the free medusa. Goette, 1904, finds, however, that in *Sarsia* the sperm originates and remains in the peripheral ectoderm of the manubrium of the medusa, but the egg-cells, contrary to Weismann's contention, originate in the *entoderm* of the medusa-bud while it is still attached to the hydroid, but afterwards they migrate into the ectoderm of the manubrium, where they mature.

Many of the species of *Sarsia* display considerable individual variability, the colors of the manubrium and tentacle-bulbs ranging from green or yellow to red. An apical projection and an axial vessel above the stomach may or may not be developed, and the length of the manubrium at maturity is subject to much variability. Moreover, the hydroids may form densely or sparingly branched colonies in accordance with environmental conditions, and as is well known in *S. mirabilis*, free medusæ are produced in early spring, whereas late in the season the medusæ mature while still attached to the hydroids. Much confusion has been introduced into the synonymy of the genus, and different stages of the same medusa have occasionally received different specific names.

*Sarsia "nodosa"* Busch, 1851, appears to be the young of some European *Sarsia*. The exumbrella of very young medusæ of *Sarsia* are usually besprinkled with nettling cells and their tentacles bear prominent nematocysts, and Busch's medusa displays both of these characters. (See Hartlaub, 1907, Nordisches Plankton, Nr. 12, p. 68, fig. 64.)

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*Tabular Description of the Medusæ of Sarsia.*

| | S. tubulosa Lesson, 1843*. | S. mirabilis L. Agassiz, 1849.† | S. eximia = Syncoryne eximia Hincks, 1868. | S. radiata von Lendenfeld. | S. conica = Codonium conicum Haeckel. |
|---|---|---|---|---|---|
| Shape and size of bell in mm. | Egg-shaped. Half-ellipsoidal. 10 to 12 high, 6 to 8 wide. With or without apical projection. | As in S. tubulosa, 7 to 10 high, 4 to 8 wide. | Oval with quite thick walls. 3 high, 2 wide. | Semi-ovate. 3 high, 2.5 wide. | Barrel-shaped with long pointed apex. 12 high, 4 wide. |
| Character of 4 tentacles. Length in terms of bell-radius (*r*). | Basal bulbs small; each with abaxial ocellus. Tentacles about 4 to 6 *r* long, and without prominent clusters of nettle-cells. | As in S. tubulosa. | Basal bulbs large, with abaxial ocellus on each. Tentacles about 4 *r* long. | As in S. eximia. | 7 *r* long, with small basal bulbs. |
| Shape and length of manubrium in terms of bell-radius (*r*). | Narrow, cylindrical at its base. Middle part cylindrical, swollen by gonad. Stomach small, spindle-shaped. Mouth at end of short conical neck, as in S. mirabilis. Length 4 *r*. | Narrow tubular base. Mid-region swollen and cylindrical. Line of demarcation between narrow, cylindrical, basal, and wide middle part very sharp. Stomach swollen and spindle-shaped and near outer end of the manubrium. Beyond stomach there is a short, tapering, narrow neck. Mouth is a round opening. Total length 3 to 6 *r*. Average 4 *r*. | Cylindrical; wide above, with narrow, short, tubular neck above mouth. Length about 2 *r* or less. | As in S. eximia, 1.5 *r* long or less. | Spindle-shaped, only 1.5 to 2 *r* long. |
| Gonads. | Ring-like and developed over nearly the whole length of the manubrium, leaving a short distance at both ends free. No medusa-buds. | Thick ring encircling manubrium. Beginning abruptly at a short distance from base, and extending to upper part of stomach, leaving both ends of manubrium free. | Encircles manubrium from base to mouth end, leaving only short neck above the mouth free. No medusa-buds. | As in S. eximia. | Encircles stomach, leaving both ends free. |
| Color. | Entoderm of stomach green, bluish lilac, or red. Tentacle-bulbs green, blue, or red. Ocelli black. | Entoderm of stomach usually green, sometimes green and red, or red. Tentacle-bulbs green or red. Ocelli black. | Entoderm of stomach yellowish-red to reddish-brown or green. Ocelli black in young and red in mature medusa. Tentacle-bulbs red, or brownish-red. | Entoderm of manubrium and tentacle-bulbs deep brown. | ? |
| Where found. | North Atlantic coasts of Europe to Arctic Ocean. | From coast of New Jersey northward to Arctic Ocean. Coasts of Norway, northern Russia, Greenland, Alaska to northern Chile along Pacific coast to South America. | Coast of England, Scotland, Helgoland, Norway, Juneau, Alaska, North Pacific (Nutting). | New South Wales, Australia. | Indian Ocean. |
| Hydroid. | Syncoryne sarsia Loven. Hartlaub, 1905, describes (this hydroid ?) from Terra del Fuego, Antarctic. | Syncoryne "mirabilis" L. Agassiz. S. reticulata is a closely related variety (see text). | Syncoryne eximia, Allman. | Syncoryne radiata. | Unknown. |

*Description based on accounts by European writers.
†Description based on original observations of medusæ found off southern coast of New England, United States.

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A number of *Syncoryne* hydroids have been described which probably produce *Sarsia* medusæ, but are not known so to do. Among these may be mentioned *Syncoryne crassa* Pictet, 1893 (Revue Suisse Zool., tome 1, p. 8), a small hydroid only 2 mm. high and relatively thicker and shorter than *S. pulchella* of Allman, 1871 (Monog. Tubularian Hydroids, p. 279, plate 6, fig. 3). Pictet's hydroid comes from Amboina, Malay Archipelago. It has 30 to 40 short, knobbed tentacles, and the medusa-buds arise singly between the tentacles. The hydrorhiza is net-like, and the hydroid is pale orange in color.

Hartlaub, 1907, has made a masterly study of the genus *Sarsia*, and shows that the species fall conveniently into two groups: the *Eximia* group, with short manubrium occupied entirely by the gonad, which extends from its base to near the mouth, and the *Tubulosa* group,

*Tabular Description of the Medusæ of Sarsia.—Continued.*

| | S. prolifera Forbes = S. codonophora Haeckel. (See text.) | S. gemmifera Forb. = S. siphonophora Haeckel. | S. hargitti = S. producta Hargitt. | S. flammea Hartlaub, 1907. | Sarsia (Stauridiosarsia) producta = Stauridia producta Wright, Hartlaub. |
|---|---|---|---|---|---|
| Shape and size of bell in mm. | Bell-shaped, with or without apical projection. 2.5 to 8 high, 3 to 8 wide. | Bell ellipsoidal. 8 high, 6 wide. | Pyriform. 1.5 high, 1 wide. | Oval. 12 high, 7 wide. | Three-fourths-egg-shaped. 10 high, 7 wide. |
| Character of 4 tentacles. Length in terms of bell-radius (*r*). | Basal bulbs very large and wide, with black or red ocelli. Tentacles hollow, tapering. 2 to 6 *r* long; with clusters of medusa-buds upon their bases. | Well-developed basal bulbs with abaxial ocelli. Tentacles 4 *r* long. | Well-developed basal bulbs with abaxial ocelli. Tentacles 2 *r* long. | Tentacle tips knob-like. Shafts covered with broken (partial) rings. No ocelli. | Large basal bulbs with abaxial ocelli. Tentacles about 3 to 4 *r* long. |
| Shape and length of manubrium in terms of bell-radius (*r*). | Spindle-shaped with narrow neck and simple, round mouth-opening. About 1.5 *r* long. | Very long, tubular, with spindle-shaped stomach near outer end. Mouth at extremity of narrow neck. Manubrium 8 *r* long. | Spindle-shaped at both ends, narrower and tubular in middle. 2 to 3 *r* long. A circlet of medusiform gonads (= medusa-buds?) near proximal end of manubrium. | Conical—spindle-shaped, only two-thirds as long as the depth of the bell-cavity. | Cylindrical, about 3 *r* long. |
| Gonads. | Encircling stomach. Medusæ produced asexually upon the tentacle-bulbs. | Gonad (?) Medusæ produced asexually by budding from sides of manubrium. There may be 10 to 22 or more of these budding medusæ upon manubrium at one and same time. Law of budding discussed in text. | Gonad (?) Medusiform buds on stomach in circlet near base. | Ring-like, encircling the manubrium from its base to near mouth. | Gonad at base of stomach. No medusa-buds. |
| Color. | Entoderm of tentacles and stomach yellow to sage-green. Mouth orange. Ocelli brown. Tentacle-bulbs contain red entodermal pigment. | Entoderm of stomach, tentacles, and radial-canals orange-yellow to orange-red. Ocelli black. | Basal part of manubrium orange. Distal end blue-green. Tentacle-bulbs orange, edged with green. Ocelli black. | Entoderm fiery red or orange. | Stomach brownish, gonads yellowish-white, tentacle-bulbs red. Ocelli black. |
| Where found. | English Channel to Mediterranean. | Atlantic coasts of Europe, from Norway southward to Canary Islands. | No Man's Land, near Woods Hole, Massachusetts, United States. A single specimen was found. | Arctic Ocean. | Coast of Great Britain to Helgoland. |
| Hydroid. | Unknown. | Unknown. | Unknown. | | Stauridia producta. |

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with long, tubular manubrium with the gonad confined to a short length near its free outer end. He states that the *Eximia* group are represented by such forms as *Sarsia eximia, brachygaster, flammea, barentsi, prolifera, angulata,* and *apiculata.* The *Tubulosa* group are represented by *S. tubulosa, densa, decipiens, litorea, pulchella, frutescens, mirabilis, reticulata, princeps, rosaria,* etc.

The genus *Plotocnide* Wagner, 1885, is defined by Hartlaub, 1907, as a *Sarsia*-like medusa with nettle-cells upon the exumbrella. The gonad surrounds the manubrium from the base downward. No ocelli. Hydroid unknown. It appears to me that unless it be proven that the hydroid is different from *Syncoryne,* this genus should be merged with *Sarsia.*

Weismann, 1881 (Zool. Anzeiger, Bd. 4, p. 61), shows that the circulation of fluids within the gastrovascular cavity of *Coryne pusilla* is aided by the rhythmical contraction of the walls of the gonophore. The systole and diastole are not always of equal duration, but each ranges from 60 to 75 seconds. Thus the circulation in certain hydroids may be aided by periodic peristaltic contractions as well as by the movement of cilia.

Annandale, 1907, Journal and Proc. Asiatic Society of Bengal, vol. 3, finds *Syncoryne filamentata,* sp. nov., developing free medusæ and growing in brackish pools of one-third the salinity of sea water at Port Canning, Lower Bengal. The mature medusa is unknown.

*Tabular Description of the Medusæ of Sarsia.—Continued.*

| | S. rosaria = Coryne rosaria A. Agassiz, 1865. | S. minima von Lendenfeld. | S. brachygaster Grönberg, 1898. | S. angulata Mayer. | S. gracilis Browne, 1902. | S. princeps Haeckel, 1879. |
|---|---|---|---|---|---|---|
| Shape and size of bell in mm. | Oval, with small apical projection. 15 to 30 high, 10 to 15 wide. | Ovate. 3 high, 2.5 wide. | Three-fourths-egg-shaped, widest above the middle. 15 to 18 high, 8 to 10 wide. | Half-egg-shaped. 3 high, 2.8 wide. 4-sided in contraction. | Cylindrical, thick-walled. 5 high, 3 wide. | Conical with thin walls. 28 to 40 high, 15 to 30 wide. |
| Character of 4 tentacles. Length in terms of bell-radius (*r*). | Basal bulbs large; each with abaxial ocellus. Tentacles 3 to 4 *r* long. Basal bulbs flanked by pads of nettle-cells. | Tentacles about 2.5 *r* long. | Basal bulbs large with a small abaxial ocellus. Tentacles 3 to 4 *r* long. | Basal bulbs large, with well-developed abaxial ocellus. Tentacles 2 *r* long. | Ocelli on basal bulbs. Each tentacle 3 *r* long, terminating in a nematocyst-knob. | Basal bulbs elongate, conical, and flanked by pad-like clusters of nematocysts. Each bulb bears small abaxial ocellus. Tentacles 8 *r* long. |
| Shape and length of manubrium in terms of bell-radius (*r*). | Spindle-shaped, only 1.5 to 2 *r* long. | As in S. rosaria. | As in S. eximia. | Shaped as in S. rosaria. *r* to one-twelfth *r* long. | Two-thirds as long as the depth of the bell-cavity. | Tubular, cylindrical, with a round mouth-opening 4 *r* long. |
| Gonads. | Encircles stomach, leaving both ends free. No medusa-buds. | As in S. rosaria. | As in S. eximia. | As in S. rosaria. | (?) | As in S. rosaria. |
| Color. | Entoderm of stomach ranges from yellow to pink or reddish-brown to purple. Tentacle-bulbs yellowish-brown to red. | Entoderm brown. | Entoderm of stomach and tentacle-bulbs orange-red. Ocelli black. | Entoderm of stomach and tentacle-bulbs robin-egg blue; never red. Ocelli deep-brown. | (?) | Entoderm of tentacle-bulbs and manubrium purple. Ocelli black. |
| Where found. | Pacific coast of North America, southern California to Puget Sound. | Port Jackson, New South Wales, Australia. | Spitzbergen and Greenland, in summer. | Bahamas to Tortugas, Florida. Winter to mid-summer. | Stanley Harbor, Falkland Islands. | Greenland and Spitzbergen, in summer. |
| Hydroid. | Syncoryne rosaria A. Agassiz and Fewkes. | Syncoryne minima. | Unknown. | Unknown. | (? ?) Syncoryne sarsii Hartlaub, 1905 (?) Is this medusa a young Slabberia? | Unknown. |

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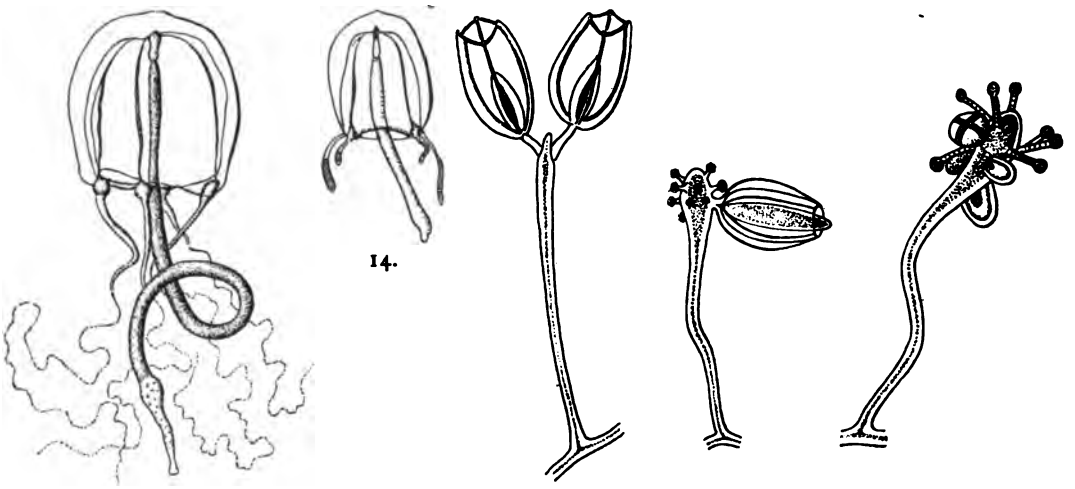
## Sarsia tubulosa Lesson.

*Syncoryna sarsii* (hydroid), LOVEN, 1835, K. Vet. Acad. Handl. för Ar., p. 275, plate 8, figs. 7-10.
*Oceania tubulosa* (medusa), SARS, M., 1835, Beskriv og Jagtt., p. 25, plate 5, fig. 11. Also: *Syncorine sarsii*, 1846, Fauna littor. Noveg., part. 2, p. 2, tab. 1, figs. 1-6.
*Syncoryne sarsii*, LOVEN, 1837, Archiv. für Naturgesch., Jahrg. 3, p. 321, taf. 6, fig. 25.—WEISMANN, 1883, Entsteh. Sexualzellen bei Hydromedusen, Jena, pp. 56, 216.—GARSTANG, 1894, Journal Oxford Club, vol. 2, No. 30, p. 7.—CITRON, 1902, Archiv. Naturges., Jahrg. 68, pp. 1, 26, taf. 1, 2 (sensory cells of tentacles).—HINCKS, 1868, British Hydroid Zoophytes, p. 52, plate 7, fig. 3.—ALLMAN, 1872, Monog. Tubularian Hydroids, p. 275.
*Syncoryne sarsi* and *Sarsia tubulosa*, BEDOT, 1905, Revue Suisse de Zool., tome 13, pp. 120, 147 (all literature 1835-1850).
*Sarsia tubulosa*, LESSON, 1843, Hist. Zooph. Acalèphes, p. 333.—SCHULZE, 1873, Ueber den Bau von Syncoryne Sarsii, p. 14, taf. 3.—ROMANES, 1885, Jellyfish, Star-fish, and Sea Urchins, etc., International Scientific Series, vol. 49 (reactions to stimuli).—LINKO, 1905, Zool. Anzeiger, Bd. 28, p. 212.—HARTLAUB, 1907, Nordisches Plankton, Nr. 12, p. 19, figs. 10-16.—BROWNE, 1903, Bergens Museums Aarbog, No. 4, p. 9; 1895, Proc. and Trans. Liverpool Biol. Soc., vol. 9, p. 246.
*Sarsia tubulosa*, SARS, 1835=*Sarsia macrorhyncha*, BUSCH, 1851; BROWNE, E. T., 1905, Proc. Royal Soc. Edinburgh, vol. 25, p. 758.
*Syncoryne gravata*, HINCKS, 1868, Hist. British Hydroid Zooph., p. 53.
*Sarsia tubulosa*+*S. macrorhyncha*, HAECKEL, 1879, Syst. der Medusen, pp. 16, 19.
*Sarsia tubulosa*+*S. pulchella*, FORBES, 1848, British Naked-eyed Medusæ, pp. 55, 57, plate 6, figs. 2, 3.
*Coryne pusilla*, AGASSIZ, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 340.
(?) *Syncoryne Sarsii*, HARTLAUB, 1905, Zoolog. Jahrbüchern, Suppl. 6, p. 525, fig. F (hydroid from Terra del Fuego).
*Sarsia macrorhyncha*, BUSCH, 1851, Beobach. wirbell. Seeth., p. 10, taf. 3, figs. 7-10; taf. 4, figs. 1, 2.



13. 14. 15. 15.

FIG. 13.—"*Sarsia litorea*," after Hartlaub, in Nordisches Plankton.
FIG. 14.—"*Sarsia decipiens*," after Hartlaub, in Nordisches Plankton.
FIG. 15.—"*Syncoryne gravata*," after Hincks, in British Hydroid Zoophytes—probably hydroid of *Sarsia mirabilis*.

This medusa is found off the English coast early in the spring, but it disappears before August. It is evidently an Arctic species, is abundant off the northern coasts of Europe, and is found off Iceland. It is very closely related to, if not identical with, the American *S. mirabilis*, but may possibly be distinguished by its more slender and higher bell, its very long manubrium, and its somewhat shorter tentacles. All of these characters are, however, very variable in *Sarsia mirabilis*, and I have become convinced that the American and European forms are at most only varieties, one of the other. For details see the tabular description of medusæ of *Sarsia*.

Romanes, 1885, carried out many interesting physiological experiments upon this species, and showed that its ocelli are organs for the perception of light. The medusa is sensitive only to rays between the red and violet, and is strongly attracted by the light. The smallest part of the bell-margin is capable of initiating and maintaining the rhythm of the bell, but if the margin be entirely removed all pulsations of the bell instantly cease, while the cut-off margin continues to pulsate. Stimulation of the subumbrella of the bell causes contraction of the manubrium (proboscis), and indeed the bell, when deprived of its margin, still responds by contractions to all sorts of stimuli, chemical, thermal, electrical, or mechanical, although sustained rhythmical pulsation is never resumed.

The hydroid is *Syncoryne sarsii*, which is common in shallow water along the coasts from England to Norway. The polypites are spindle-shaped and elongate and have about 12 to

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## Plate 4.

Fig. 1. *Sarsia mirabilis*. Abnormal medusa with a tentacle arising from the side of the manubrium. Nahant, Massachusetts, May 8, 1897. Metschnikoff, 1870, observed a similar abnormality in *Slabberia catenata*.

Fig. 2. Median section of a young medusa of *Sarsia mirabilis*. The ocellus on the right-hand tentacle is shown as if depigmented in order to illustrate its structure. The eye on the left-hand tentacle-bulb is shown normally pigmented.

Figs. 3 and 4. *Sarsia mirabilis* var. *reticulata*, young medusa. Figure 4, one of the nematocyst-cells from the tentacles of figure 3. Agassiz Laboratory, Newport, Rhode Island, June 13, 1895.

Drawn from nature, by the author.

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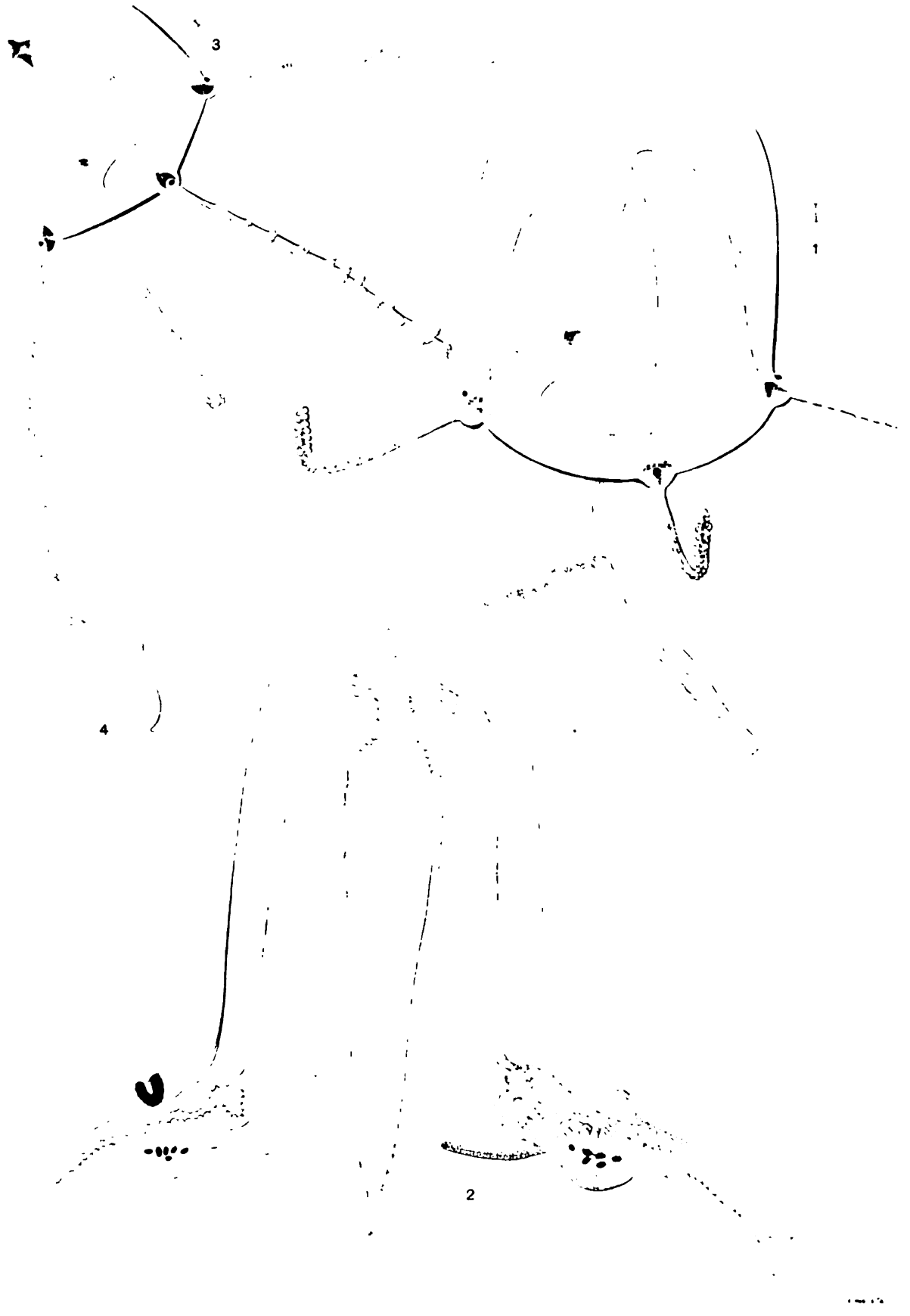


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16 short tentacles which arise at irregular intervals from their sides. Each of these tentacles ends in a knob-like cluster of nematocysts. The 2 or 3 medusa-buds arise from the sides of the polypite *between* the tentacles. The stems of the hydroid are quite smooth, sparingly branched, and about 12 to 15 mm. high. The stems are translucent, slightly horny in color, and the polypites are light-red.

I can not determine any well-defined distinctions between *S. sarsii* and *S. mirabilis*, excepting that in *S. sarsii* the medusa-buds appear always to arise from near the *middle* of the sides of the polypite between the tentacles, whereas in *S. mirabilis* the medusa-buds arise from near the *base* of the polypite at or below the level of the lowest zone of tentacles.

Hartlaub has given excellent figures and descriptions of a number of medusæ which are closely related to *Sarsia tubulosa*, if not mere varieties of the latter. These are *S. pattersoni* Haddon, *S. frutescens* Allman, *S. decipiens* Hartlaub, *S. litorea* Hartlaub, and *S. pulchella* Forbes. (See Hartlaub, 1907, Nordisches Plankton, Nr. 12, pp. 29, 30, 32, 36; figs. 20–22*b*, 23, 24, 28, 29.) I hesitate to quote these as distinct species, for I have observed the same or nearly the same variations among individuals in swarms of *S. mirabilis* at Nahant, Woods Hole, and Newport on our coast. A statistical study, or better still, a study of the respective hydroids, is required before we can hope to determine these so-called "species" with certainty.

Garstang, 1894, observes that the hydroid of *S. tubulosa* gives rise to dimorphic medusæ, as does *S. mirabilis* on the coast of New England, where early in the spring the medusæ are set free, whereas in May they mature while still attached to the hydroid.

### Sarsia tubulosa Lesson, variety Sarsia mirabilis L. Agassiz.

Plate 3, figs. 2, 4, and 5; plate 4, figs. 1 and 2.

LITERATURE RELATING TO THE AMERICAN VARIETY OF SARSIA TUBULOSA.

*Sarsia mirabilis*, AGASSIZ, L., 1849, Mem. Amer. Acad., New Ser., vol. 4, p. 224, plates 4, 5.—STIMPSON, 1853, Marine Invert. Grand Manan, p. 11.—HAECKEL, 1879, Syst. der Medusen, p. 17.—FEWKES, 1881, Bull. Mus. Comp. Zool. at Harvard Coll., vol. 8, p. 141, plate 3, figs. 11, 12.—LEVINSEN, 1893, Vid. Meddel. Nat. For. Kjöbenhavn (5), Bd. 4, p. 143.—BIRULA, 1896, Annuaire Musée Zool. Imp. Sci. St. Pétersbourg, tome 1, p. 332.—HARTLAUB, 1907, Nordisches Plankton, Nr. 12, p. 37, figs. 30–40.—LINKO, 1900, Mém. Acad. Sci. St. Pétersbourg, sér. 8, vol. 10, No. 4, p. 11, taf. 1, figs. 1–12 (structure of ocelli); 1905, Zool. Anzeiger, Bd. 28, p. 212; 1900, Traveaux Soc. Impériale des Nat. St. Pétersbourg, tom. 29, p. 151.

*Sarsia mirabilis* (medusa), AGASSIZ, L., 1862, Cont. Nat. Hist. U. S., vol. 4, pp. 211–217; vol. 3, *Ibid.*, plate 18, figs. 15–25*a*.

*Sarsia glacialis*, MÖRCH, 1857, Beskriv af Grönland, p. 95.

*Coryne mirabilis* (hydroid), AGASSIZ, L., 1862, Cont. Nat. Hist. U. S., vol. 4, pp. 185–211, plates 17–19; vol. 3, *Ibid.*, figs. 1–16, plate 17; figs. 1–14, plate 18; figs. 1–27, plate 19.

*Coryne mirabilis*, AGASSIZ, A., 1865, North Amer. Acal., p. 175, figs. 282–285.—CALKINS, 1899, Proc. Boston Soc. Nat. Hist., vol. 28, p. 336.

*Oceania tubulosa*, GOULD, 1841, Invert. of Mass., p. 348.

*Syncoryne mirabilis*, ALLMAN, 1871, Monog. Tubul. Hydroids, p. 278.—HARGITT, 1904, Bulletin Bureau of Fisheries U. S., vol. 24, p. 30, plate v, fig. 1; 1901, Amer. Naturalist, vol. 35, p. 578, fig. 33; 1903, Science, vol. 16, p. 344 (variations).—HARTLAUB, 1905, Zool. Jahrbüchern, p. 526; Zool. Jahrb., Syst. Abth., 1901, Bd. 14, p. 356.—TORREY, 1902, Univ. California Publications, vol. 1, p. 31.—NUTTING, 1901, Bull. U. S. Fish Commission, vol. 19, pp. 328, 372, figs. 3, 81.

(?) *Syndictyon angulatum* (young medusa), MURBACH and SHEARER, 1903, Proc. Zool. Soc. London, vol. 2, p. 168.

(?) *Sarsi barentsii* (young red-colored medusa), LINKO, 1905, Zool. Anzeiger, Bd. 28, p. 214 (north of Russia).

(?) *Euphysa tentaculata* (abnormal medusa with only 3 well-developed tentacles), LINKO, 1905, Zool. Anzeiger, Bd. 28, p. 214 (Barents Sea, North Russia).

*Syncoryne densa*, HARTLAUB, 1897, Wissen. Meeresuntersuch. Komm. Meere. Kiel, Helgoland, Neue Folge, Bd. 2, p. 452, taf. 16*b*, figs. 4, 11; taf. 16*c*, figs. 7, 8 (hydroid forms dense tufts). Also: *Sarsia* sp., HARTLAUB, 1896, Verhandl. Deutsch. Zool. Gesell., Leipzig, Bd. 6, Vers., p. 182 (medusæ with branched manubria); 1907, Nordisches Plankton, Nr. 12, p. 26, figs. 17–19, 22*a* (hydroid and medusa).

The following description is derived from a study of medusæ and hydroids obtained off the southern coast of New England, United States.

*Adult medusa.*—Bell is half-egg-shaped, about 7 mm. in height and 4 mm. in diameter. There is no apical projection, and the gelatinous substance is not very thick at the aboral pole and becomes successively thinner near the margin. There are 4 long, highly contractile tentacles, one at the base of each radial-canal. The surface of each tentacle is covered with prominent nematocyst-cells, which are clustered especially at the outer end of the tentacle. Each tentacle arises from a well-developed basal bulb which contains a single ectodermal ocellus upon the outer nerve-ring on the abaxial side of the tentacle-bulb. According to Linko, 1900, the ocellus is composed of a cup-shaped invagination of densely pigmented ectodermal cells between which there are spindle-shaped bipolar nerve-cells. The ento-

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dermal core of the tentacle is hollow, and its lumen is continuous with the gastrovascular system of the medusa. The ectodermal cells of the tentacle-bulb are very thick and are probably nervous in function. The velum is well developed, being wide and thin. There are 4 straight, slender radial-canals, and a simple, narrow, circular tube. A short, blindly-ending tube extends upward from the base of the stomach into the gelatinous substance of the bell. The entodermal cells of this small projection are several layers thick. The manubrium is long and extends far beyond the velar opening. Its proximal part is slender and tubular, but in its outer parts it is much distended by the genital products and consists of a long, wide, cylindrical tube. The line of demarcation between the narrow and the wide part of the manubrium is very sharp. The mouth is a simple opening at the extremity of a short flask-shaped proboscis, and the lips are studded with nematocysts. The mature genital products are found in the ectoderm of the distal part of the manubrium. The entoderm of the manubrium is usually green, but occasionally it is red. The entoderm of the tentacle-bulbs is either red or green, and in some individuals the entoderm of the bulb is red while the ectoderm is green.

FIG. 16.—"*Syncoryne pulchella.*"

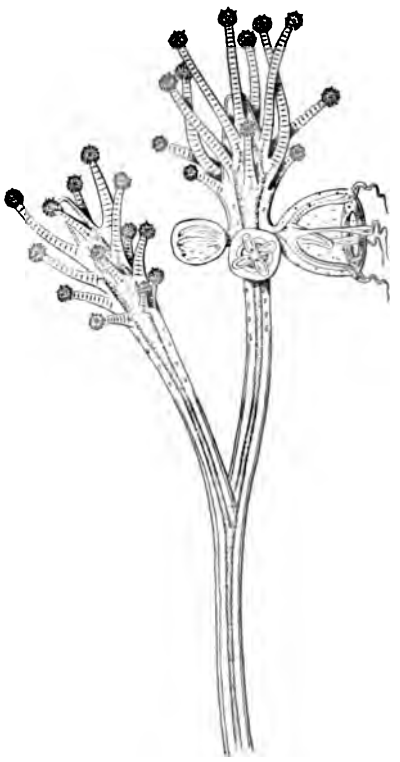

FIG. 17.—"*Syncoryne frutescens.*"

The above figures are after Allman, in Ray Society, 1871–72.

*Hydroid and young medusa.*—The hydroid stock is *Syncoryne mirabilis.* The stems are attached by a creeping stolon. They are about 15 millimeters in height and branch profusely. The main stems and also the side branches terminate each in a single polypite. The stems are incased in an unannulated chitinous perisarc, which terminates sharply at the bases of the polypites. Each polypite is fusiform and has about 12 to 18 tentacles which arise in 3 or more indefinite whorls from the sides of the polypite. These tentacles are not long, but are quite contractile. Each terminates in a knob-shaped cluster of nematocyst-cells. The mouth of the polypite is a simple round opening situated at the extremity of a conical proboscis. Medusa-buds are developed upon the sides of the polypites immediately below the tentacles, near the lower base of the polypite. Each polypite bears 1 to 4 medusa-buds in various stages of development. In Massachusetts Bay the breeding season begins early in March and lasts until the end of May. During March the medusa-buds

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develop 4 long tentacles, and are set free in an immature state, but during the last half of the breeding season they fail to develop tentacles or give rise to mere short lashes upon their basal bulbs; and they become sexually mature while attached to the hydroid, the manubrium of each bud being greatly distended with the genital products. This observation was first made by L. Agassiz, 1862 (pp. 189, 203), and has been confirmed by us in hydroid stocks obtained in Swallow's Cave, Nahant, Massachusetts. Plate 3, fig. 5, is derived from one of these sexually mature medusa-buds found upon a hydroid on May 8, 1897. It will be observed that the manubrium of the bud is distended with sperm, while the tentacles are not developed. In this connection it is interesting to observe that *Pennaria* and *Podocoryne carnea* sometimes give rise to medusæ which are sexually mature at their time of liberation, while in other stocks of the same species the medusæ are set free in an immature condition. Garstang, 1894, observes the same phenomenon in the European *S. sarsii*.

This hydroid of our *Sarsia* is very abundant, from March until May, in Massachusetts Bay, where it appears to grow equally well both in pure sea-water and in the brackish mouths of rivers. The medusæ appear in great numbers on the southern coast of New England

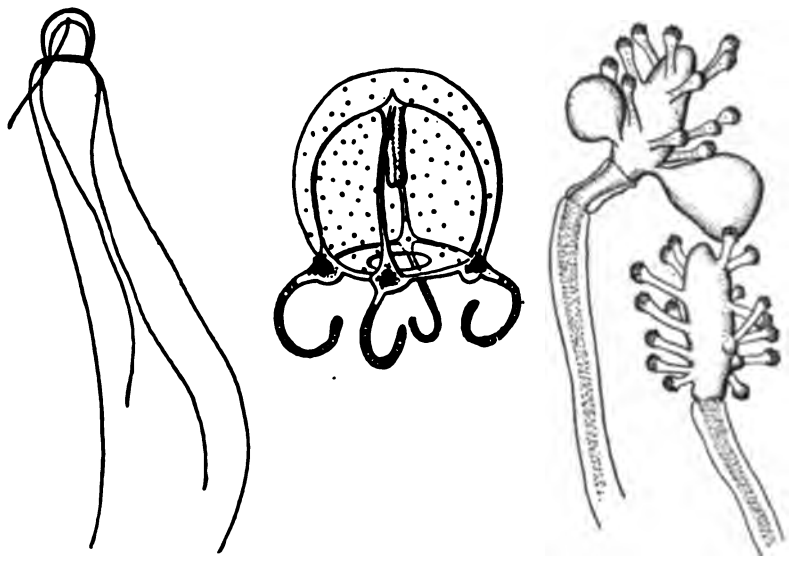

Fig. 18.—Hydroid and medusa of "*Sarsia densa*," after Hartlaub, in Nordisches Plankton.

between February and April. They become rare during May, and are not seen during the summer months. The hydroid extends northward to the Greenland coast, but has not been recorded from Beaufort, North Carolina, or farther south. Linko and Birula, 1896, found it in the White Sea, and Linko, 1905, records it from the eastern parts of Barents Sea between Kanin and Kolgujew Islands. Calkins, Torrey, and Hartlaub have found this medusa along the Pacific coast of America as far south as Chile. I believe *Syncoryne densa* Hartlaub from Helgoland to be an environmental form of *S mirabilis*.

We have observed an abnormal medusa of *Sarsia mirabilis* in which a single well-developed tentacle arose from the side of the manubrium at the point of juncture of the long tubular basal region and the gemmiferous part of the manubrium. (See plate 4, fig. 1). This abnormal tentacle was studded with clusters of nematocyst-cells. It lacked a basal bulb and had no ocellus. Asexual budding of medusæ from the walls of the manubrium is not known in *Sarsia mirabilis*. Medusæ of *Sarsia* with branched manubria are described by Hartlaub, 1896, 1907.

Professor Hartlaub finds that in *Sarsia mirabilis* the stomach is confined to the distal end of the manubrium and the gonad is confined to the mid-region of the manubrium above the stomach. Both the proximal and distal ends of the manubrium lack the gonad. On the other hand, in *S. brachygaster* and *S. eximia* there is no differentiated stomach-region, and the gonad may extend over the whole, or nearly the whole, length of the manubrium.

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The chief and possibly only well-marked point of difference between the forms *S. mirabilis* and *S. tubulosa* is that in the hydroid of *S. mirabilis* the medusa-buds arise from near the base of the polypite, whereas in the hydroid of *S. tubulosa* they arise from points higher up on the sides of the polypite, between the tentacles.

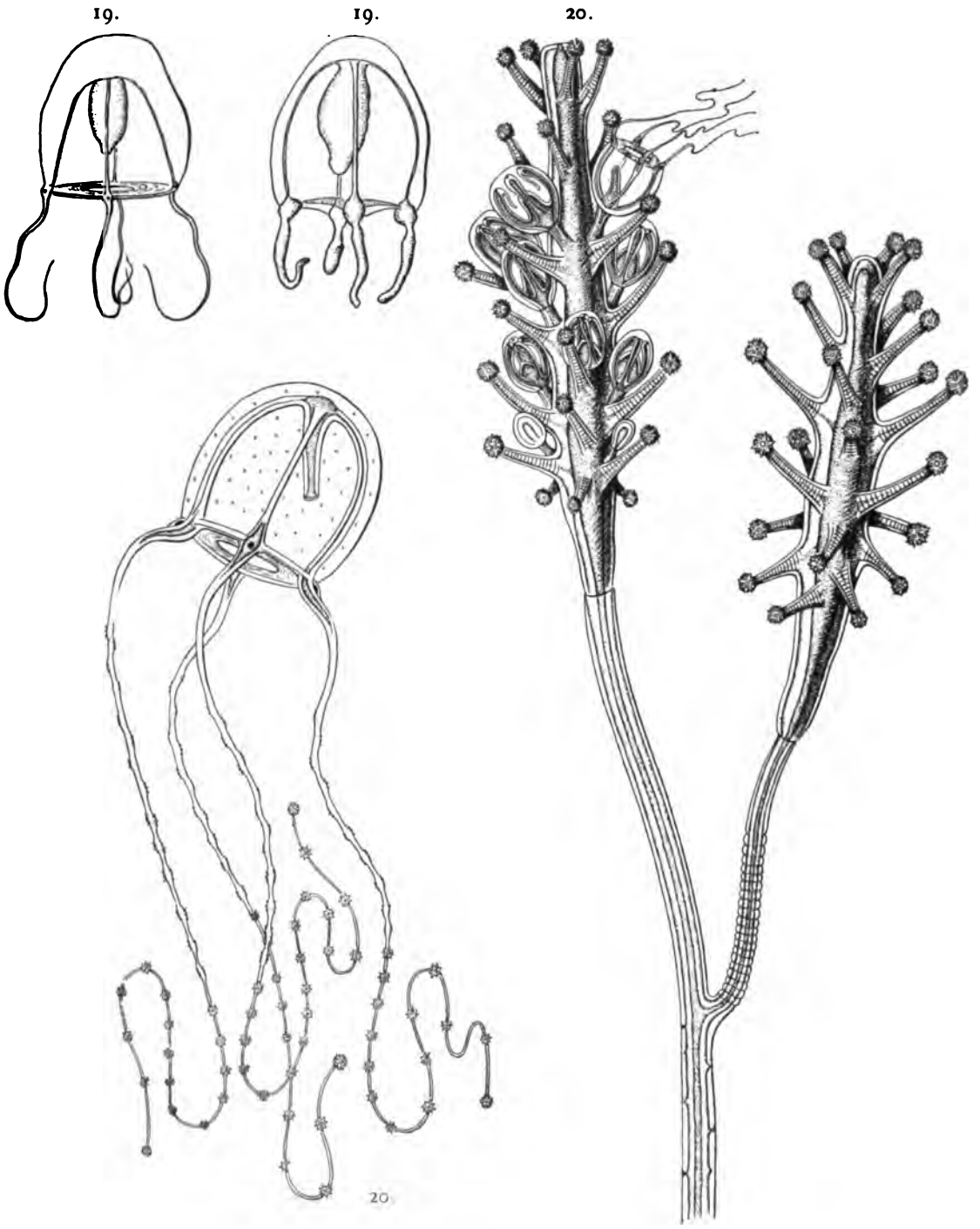


FIG. 19.—*Sarsia eximia*, after Hartlaub, in Nordisches Plankton.
FIG. 20.—*Syncoryne eximia*, after Allman, in Ray Society, 1871-72. Hydroid and young medusa.

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## Plate 5.

Fig. 1. *Sarsia angulata.* Nassau Harbor, New Providence Island, Bahamas, July, 1903.

Fig. 2. *Corynitis agassizii.* Charleston Harbor, South Carolina, September, 1897.

Fig. 3. *Ectopleura minerva.* Tortugas, Florida.

Fig. 4. *Ectopleura dumortieri*, young medusa. Agassiz Laboratory, Newport, Rhode Island, June, 1893.

Fig. 5. *Ectopleura dumortieri*, mature male. Agassiz Laboratory, Rhode Island, July, 1896.

Fig. 6. *Sarsia mirabilis* var. *reticulata.* Nahant, Massachusetts, March 25, 1897.

Drawn from life, by the author.

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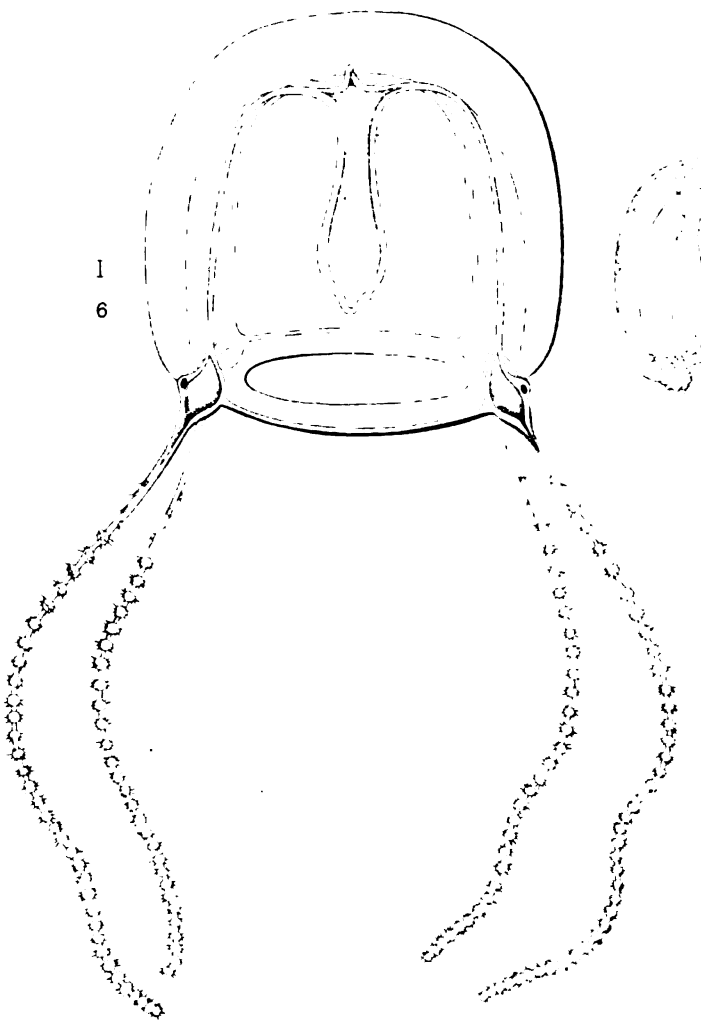


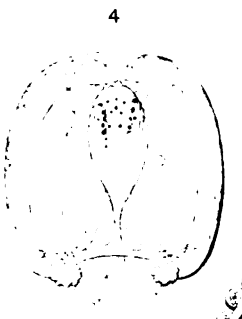


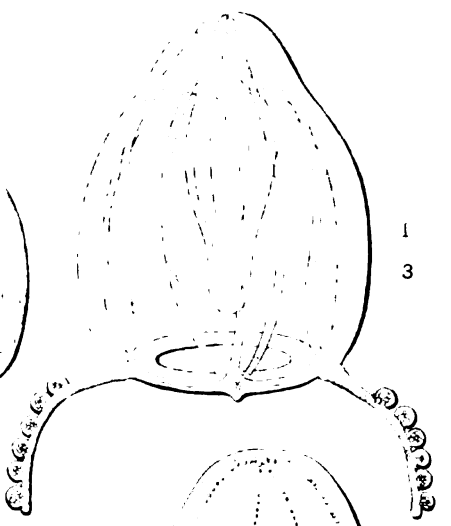


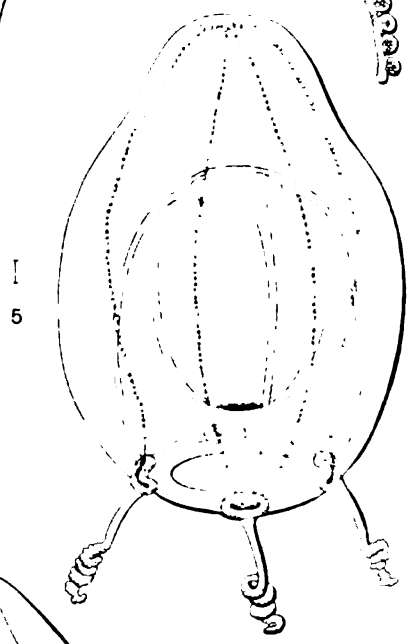


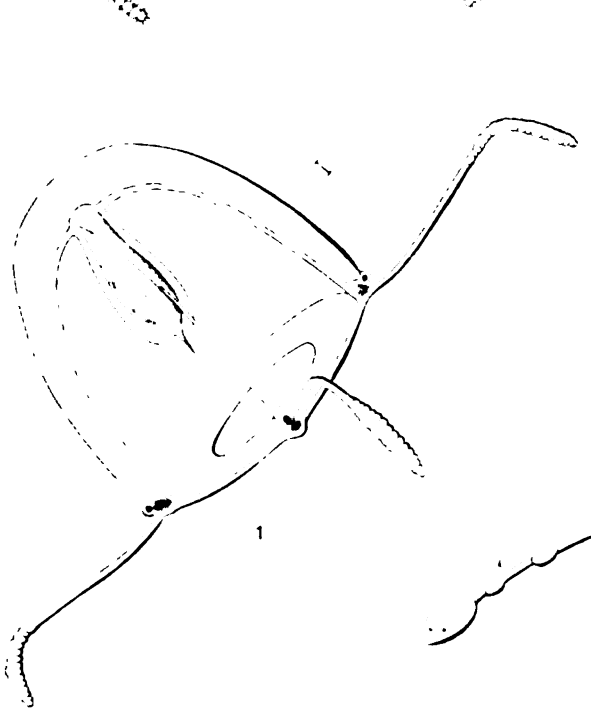


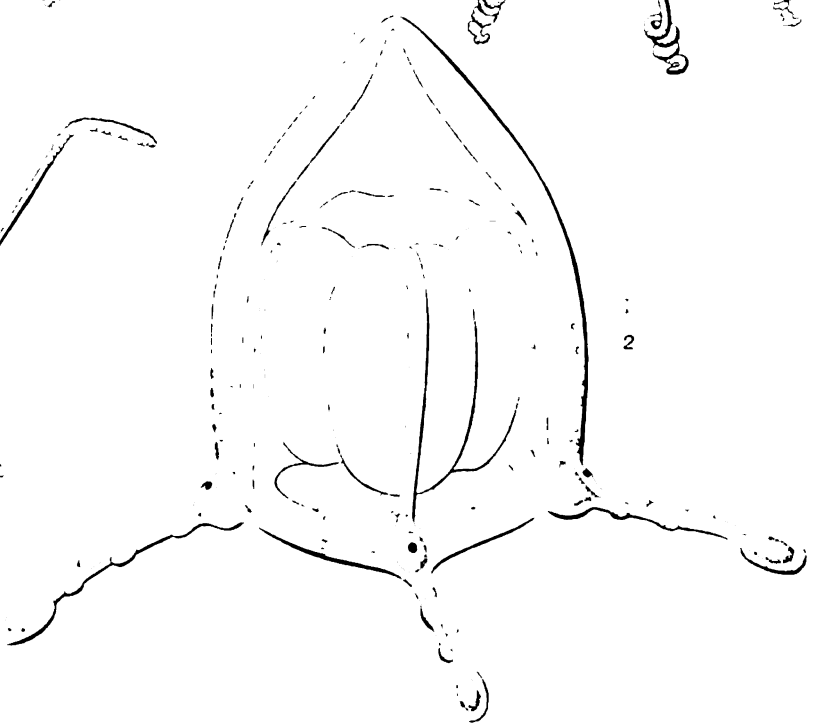


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### Sarsia mirabilis var. reticulata.

Plate 4, figs. 3 and 4; plate 5, fig. 6.

*Syndictyon reticulatum*, A. AGASSIZ in L. AGASSIZ's, 1862, Cont. Nat. Hist. U. S., vol. 4, p. 340.—AGASSIZ, A., 1865, North Amer. Acal., p. 177, figs. 290–300.
*Syncoryne reticulata*, ALLMAN, 1871, Monog. Tubul. Hydroids, p. 283.
*Syndictyon reticulatum*, HAECKEL, 1879, Syst. der Medusen, p. 21.
(?) *Syndictyon reticulatum*, MAAS, 1893, Ergeb. der Plankton-Expedition, Bd. 2, K. c., p. 67.
(?) *Sarsia turricula*, MCCRADY, 1857, Gymn. Charleston Harbor, p. 36, plate 8, figs. 6–8.
*Syncoryne reticulata*, HARGITT, 1904, Bulletin Bureau of Fisheries U. S., vol. 24, p. 30.
*Sarsia reticulata*, HARTLAUB, 1907, Nordisches Plankton, Nr. 12, p. 45, figs. 41–43.
(?) *Sarsia pulchella*, ALLMAN, 1871, see Hartlaub, 1907, Nordisches Plankton, Nr. 12, p. 34, fig. 27 (abnormal twin medusæ, fig. on p. 109).—SPAGNOLINI, 1876, Catalogo Acalefi Mediterraneo, p. 18, tav. 2, figs. 1, 2.

*Adult medusa.*—Bell ellipsoidal in shape, being about 4 mm. in height and 3.5 mm. in diameter. No apical projection. Gelatinous substance quite thick at the aboral pole, but thin at the bell-margin. There are 4 long, highly contractile tentacles, 1 at the base of each radial-canal. Surfaces of these tentacles covered with prominent nematocyst capsules. Basal bulbs of tentacles well developed and each one contains an ectodermal ocellus upon its outer side. Velum wide and thin. There are 4 straight, narrow radial-canals, and a slender circular vessel. Manubrium short and club-shaped, and does not extend far beyond the velar opening. Mouth a simple, round opening. Genital products developed along the greater part of the length of the manubrium. The entoderm of the manubrium and tentacle-bulbs is brick-red.

*Hydroid and young medusa.*—Smaller than *Coryne mirabilis*, being not more than 3 mm. in height. Stems slender and hardly ever branch, excepting in old specimens, which sometimes give rise to a single branch near the base of the stem. Polypites large and club-shaped, and having several whorls composed of 8 to 10 short tentacles. The medusæ develop among the tentacles near the proximal base of the polypite. When set free the young medusa is remarkably large, being about 1.5 mm. in diameter. The bell is covered with reticulated clusters of nematocyst-cells (plate 4, figs. 3, 4) which are especially numerous near the bell-margin above the circular canal. Some of these nematocyst-cells are large and round, while others are narrow and long. The tentacles are thickly covered with helically arranged clusters of nematocyst-cells. These cells (plate 4, fig. 4) are ellipsoidal in shape and are mounted upon a short basal pedicel. Each cell gives rise to a long, sharp-pointed, sensitive hair. The nematocyst thread lies coiled in a helix within the cavity of the cell. As the medusa becomes mature the reticulated nematocysts disappear from the surface of the exumbrella and the nematocysts upon the tentacles become less prominent. This medusa is found upon the New England coast from April until June. It is distinguished from *Sarsia mirabilis* only by its nematocyst-covered tentacles and exumbrella and its small hydroid. It appears also to be constantly brick-red, while *S. mirabilis* is highly variable in color. It is often impossible to distinguish mature medusæ of *S. reticulata* from those of *S. mirabilis*. It is possible that the *S. pulchella* of Spagnolini, 1876, from Naples, Italy, is identical with *S. reticulata*.

### Sarsia eximia Boehm.

*Coryne eximia*, ALLMAN, 1859, Annals and Mag. Nat. Hist., ser. 3, vol. 4, p. 141; 1864, *Ibid.*, vol. 13, p. 357.
*Syncoryne eximia*, HINCKS, 1868, Hist. British Hydroid Zooph., p. 50, plate 9, fig. 2.—ALLMAN, 1871, Monog. Tubul. Hydroids, p. 282, plate 5.
*Sarsia eximia*, BOEHM, 1878, Jena. Zeitschrift für Naturw., Bd. 12, p. 191, taf. 6, figs. 7–26; taf. 7, figs. 1–6.—(In part), HAECKEL, 1879, Syst. der Medusen, p. 17.—HARTLAUB, 1894, Wissen. Meeresuntersuch. Kommis. Meere. Kiel, Helgoland, Ser. 2, Bd. 1, p. 187.
*Syncoryne eximia* (hydroid), NUTTING, 1901, Proc. Washington Acad. Sci., vol. 3, p. 166, plate 14, figs. 3, 4.
*Sarsia eximia*, BROWNE, 1905, Proc. Roy. Soc. Edinburgh, vol. 25, p. 756 (hydroid and medusa).—BROCH, 1905, Bergens Museums Aarbog, No. 11, p. 4.
*Sarsia eximia*=*S. bretonica*, HARTLAUB, 1907, Nordisches Plankton, Nr. 12, p. 8, figs. 1, 2*a*, 2*b* (full list of recent literature).
*Syncoryne eximia*, BROWNE, 1907, Journal Marine Biol. Association, vol. 8, p. 37 (growth of the hydroid).

This form is found off the coasts of Great Britain, Helgoland, Shetland Islands, Norway, and Juneau, Alaska (Nutting). For details of the medusa, see tabular description of the medusæ of *Sarsia*.

The hydroid is about 30 mm. high, forming a bush-like cluster of profusely branched stems; the branches are short and simple and arise very irregularly from the main stems, and are usually faintly ringed at their points of origin. The main stem is usually unringed,

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except at its base, and is quite smooth. The polypites are very elongate, spindle-shaped, and have about 16 to 24 short, knobbed tentacles arranged in 4 to 6 somewhat irregular verticils. The medusa-buds arise singly upon short peduncles near the bases of the tentacles of the lower verticils. The entoderm is red to reddish-brown and the stems are yellow.

Browne found that confinement in an aquarium under somewhat unnatural conditions caused the hydroid to grow rapidly and to form stolons, these being developed from branches which touched the glass sides of the aquarium. He also discovered that the medusa becomes mature in from 7 to 10 days after being set free from the hydroid. Later, in 1907, Browne found that one of these hydroids placed in a glass tube with a constant current of water passing through it grew in length from 14 to 77 mm. in the course of 9 days, and developed branches having a total length of 500 mm. The hydroid was fed upon copepods.

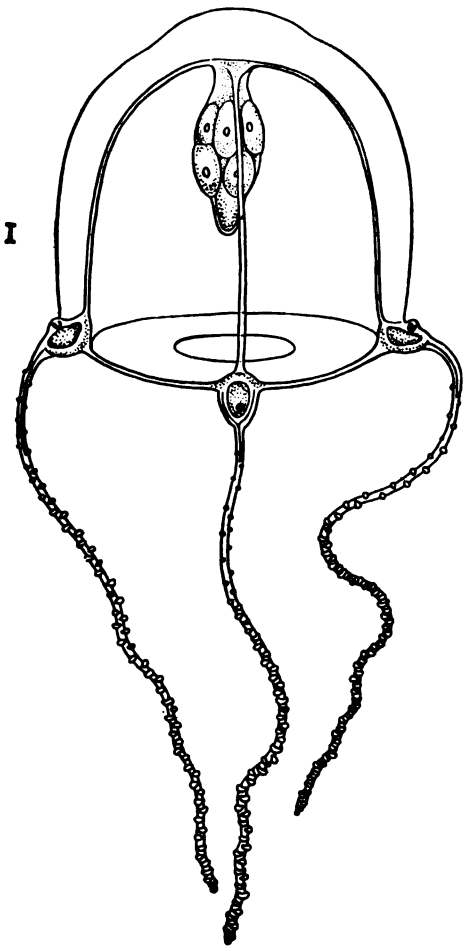


FIG. 21.—*Sarsia eximia*, from life, by the author. Mousehole, Cornwall, England, Nov. 14, 1907.

**Sarsia radiata von Lendenfeld.**

*Sarsia radiata*, VON LENDENFELD, 1884, Zool. Anzeiger, Jahrg. 7, p. 584; 1884, Proc. Linnean Soc. New South Wales, vol. 9, pp. 583, 635; plate 20, figs. 31, 32; plate 30, figs. 1–4.

*Medusa.*—Bell semiovate, slightly higher than broad, 3 mm. high, 2.5 mm. wide. 4 tentacles, each about 1.5 times as long as bell-height, and with large bulbs about half as wide as the manubrium. Ocelli (?) Velum wide. 4 straight radial-canals. Manubrium cylindrical, half as long as the bell-height. The gonad incases the sides of the manubrium from the inner apex of the bell-cavity to near the mouth. No medusa-buds. Entoderm of manubrium and tentacle-bulbs deep brown. Other parts colorless.

*Hydroid.*—The hydrocauli arise from a creeping hydrorhiza which anastomoses in a very open network. The perisarc terminates with an oblique elliptical margin at the base of each hydranth, and the hydranth is provided with a muscle at this point which enables it to bend downward and "shut up" as if it were the blade of a penknife. The hydranths are spindle-shaped, narrow, and elongate; and are, including their hydrocauli, 3 to 5 mm. high. They have 6 to 8 verticils, each of 4 tentacles, situated in 4 meridional lines, 90° apart. These tentacles are all knobbed at their ends. The hydranths which produce medusæ are shorter than the sterile polypites. The medusæ bud out from the lower half of the polypite between the tentacles. The entoderm is intensely brown in color, and the perisarc is bright brownish-yellow. Other parts colorless. Found on the coast of New South Wales, Australia. The medusæ are produced in April and May.

**Sarsia conica.**

*Codonium conicum*, HAECKEL, 1880, Syst. der Medusen, p. 634.

Bell barrel-shaped with conical apex one-third as long as the sides of bell. 12 mm. high, 4 mm. wide. 4 tentacles longer than bell-height, and with small oval basal bulbs. The manubrium is half as long as the depth of the bell-cavity. The stomach is subspherical and swollen by the encircling gonad. The mouth is at the end of a short, cylindrical throat-tube which is free of gonads. Color (?) There is a long axial canal above the stomach. Indian Ocean. Briefly described, without figures, by Haeckel.

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### Sarsia rosaria Haeckel.

*Coryne rosaria*, AGASSIZ, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 340.—AGASSIZ, A., 1865, North Amer. Acal., p. 176, fig 289.
*Sarsia rosaria*, HAECKEL, 1879, Syst. der Medusen, p. 18.
*Sarsia rosaria=Syncoryne rosaria*, FEWKES, 1889, Amer. Naturalist, vol. 23, p. 597, plate 25, fig. 7; text-figs. 8, 9 (hydroid?).
*Syncoryne occidentalis*, FEWKES, 1889, Bull. Essex Inst., Salem, vol. 21, No. 7, p. 99, plate 3, figs. 2, 3.
(?) *Syndictyon angulatum*, MURBACH and SHEARER, 1903, Proc. Zool. Soc. London, vol. 2, p. 168.
*Codonium apiculum*, MURBACH and SHEARER, 1903, Proc. Zool. Soc. London, vol. 2, p. 165, plate 17, fig. 1; plate 22, figs. 4, 5; 1902, Annals and Mag. Nat. Hist., ser. 7, vol. 9, p. 72.
*Sarsia apicula+S. rosaria*, HARTLAUB, 1907, Nordisches Plankton, Nr. 12, pp. 17, 50, figs. 9, 45.

Bell 15 to 30 mm. high, 10 to 15 mm. wide, with fairly thick walls and small apical projection. 4 equally developed, radially placed tentacles 1.5 to 2 times as long as bell-height. The basal bulbs of these tentacles are large and are flanked on either side by a large nematocyst-pad. Each tentacle-bulb bears an abaxial ocellus. There are 4 slender, straight-edged radial-canals and a narrow ring-canal. The velum is well developed. Manubrium short and spindle-shaped, and mouth about at the level of the velar opening. There is a short axial canal above the stomach. The gonad encircles the stomach, leaving both ends free. No medusa-buds. The colors are quite variable as in other species of *Sarsia*. The tentacle-bulbs range from yellow through red to brownish-red, and the stomach is yellow, pink, or reddish-violet to purple.

This is the most abundant *Sarsia* along the Pacific coast of the United States. It occurs in great swarms in San Francisco Harbor in spring; and in Victoria Harbor, Puget Sound, in July.

The hydroid is *Syncoryne rosaria* found by A. Agassiz and Fewkes in shallow water attached to piles of wharves. Each tentacle terminates in a knob, and the hydroid is a true *Syncoryne*.

### Sarsia minima von Lendenfeld.

*Sarsia minima*, VON LENDENFELD, 1884, Proc. Linnean Soc. New South Wales, vol. 9, pp. 584, 915, plate 21, figs. 34, 35.

Bell of medusa 3 mm. high and 2.5 mm. wide with "a *long* manubrium like the northern Sarsiæ." It is therefore readily distinguished from *Sarsia radiata*, which has a short manubrium. *S. minima* has a spindle-shaped, nearly cylindrical manubrium which extends for about half its length beyond the velar opening. The 4 marginal tentacles are somewhat longer than the bell-height and are covered with rings of nematocysts. The entoderm of the stomach is pale brown, other parts colorless.

*Hydroid*.—The stems are 2 to 3 mm. high and arise from a creeping, slightly branched, non-anastomosing hydrorhiza. The perisarc which invests the hydrorhiza and hydrocauli is irregularly annulated or wavy throughout, and terminates at the bases of the hydranths in a transverse margin. The hydranths are slender, spindle-shaped, 0.6 to 0.8 mm. long, and with 8 to 12 irregularly scattered tentacles, all of which are knobbed at their ends. When they produce buds they become stouter, and are so thickly covered by the budding medusæ "that nothing of their bodies remains visible." The perisarc is reddish-brown.

This hydroid is found at Port Jackson, New South Wales, Australia, overgrowing *Obelia geniculata*, on buoys and submerged ropes. The medusæ are produced in April and May. Von Lendenfeld did not obtain any mature medusæ.

### Sarsia brachygaster Grönberg.

*Sarsia brachygaster*, GRÖNBERG, 1898, Zoolog. Jahrb., Abth. Syst., Bd. 11, p. 459, taf. 27, figs. 3, 4.—HARTLAUB, 1907, Nordisches Plankton, Nr. 12, p. 11, fig. 3.

Bell 15 to 18 mm. high and 8 to 10 mm. wide and three-fourths-egg-shaped, the greatest breadth being above the middle. 4 radially situated tentacles, each being about twice as long as the bell-height. Basal bulbs of these tentacles well developed, and a single very small ocellus upon the outer side of each bulb. Manubrium cylindrical, and two-thirds as long as height of bell-cavity. Mouth situated at extremity of a short cylindrical neck. The gonad is tubular and surrounds the stomach. No medusa-buds. The manubrium, gonads, tentacle-bulbs, and tentacles are orange-red. The ocelli are black.

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Grönberg found this species at Spitzbergen in summer, and he also identified it among a collection of medusæ from Jakobshavn, Greenland, where it appears to be rarer than at Spitzbergen.

### Sarsia angulata Hartlaub.

Plate 5, fig. 1; plate 6, fig. 3.

*Syndictyon angulatum*, MAYER, 1900, Bull. Mus. Comp. Zool. at Harvard College., vol. 37, p. 5, figs. 6–8, plate 3; 1904, Memoirs Nat. Sci. Brooklyn Institute Museum, vol. 1, No. 1, p. 7, plate 1, fig. 6.
*Non Syndictyon angulatum*, MURBACH and SHEARER, 1903, Proc. Zool. Soc. London, vol. 2, p. 168.
*Sarsia angulata*, HARTLAUB, 1907, Nordisches Plankton, Nr. 12, p. 16.

Bell 3 mm. high; half-egg-shaped, with moderately thick walls. Becomes almost square in cross-section when contracted. There are 4 slender tentacles with fairly thick spindle-shaped ends. These tentacles are each about as long as bell-height and their distal halves are tapering and are armed with nematocysts. The basal bulbs of the tentacles are not very large, and each one bears an ocellus formed by a cup-like invagination of ectodermal cells. The velum is large, and the radial-canals and circular vessel are of fine caliber. The manubrium is spindle-shaped with a narrow tubular œsophagus and without an aboral projection. It is about two-thirds as long as the height of the bell-cavity. The gonad encircles it, extending from the base to near the mouth, leaving the throat-tube free. The entoderm of the tentacle-bulbs and manubrium is robin-egg blue, while the ocelli are deep-brown, almost black. All other parts are hyaline. This medusa is abundant in the Tongue of the Ocean, Bahama Islands, in June and July, and was found at Turks Island in January. It is rare at Tortugas, Florida.

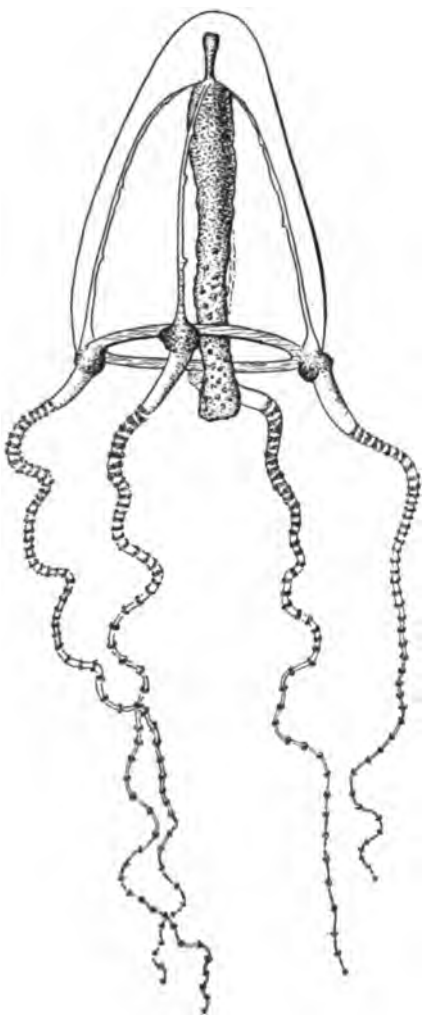

FIG. 22.—*Sarsia princeps*, after Hartlaub, in Nordisches Plankton.

### Sarsia gracilis Browne.

*Sarsia gracilis*, BROWNE, 1902, Annals Mag. Nat. Hist., ser. 7, vol. 9, p. 275.
(? ?) *Syncoryne sarsii* (hydroid), HARTLAUB, 1905, Zoolog. Jahrbüchern, Suppl. 6, p. 525, fig. F.

Bell 5 mm. high, 3 mm. wide; cylindrical, with moderately thick walls and quadrangular margin. 4 tentacles, about as long as the bell-height, and ending each in a large knob containing nematocysts. An ocellus on the basal bulb of each tentacle. Manubrium about two-thirds as long as the depth of the umbrella cavity. Color (?) Gonads (?) Found at Stanley Harbor, Falkland Islands, by Vallentin, and briefly described without figures by Browne. The hydroid, *Syncoryne sarsii*, described by Hartlaub from southern Terra del Fuego, may be the stock of this medusa.

The medusa may be a young *Slabberia* (?)

### Sarsia princeps Haeckel.

*Codonium princeps*, HAECKEL, 1879, Syst. der Medusen, p. 13, taf. 1, figs. 1, 2.
*Sarsia princeps*, HAECKEL, 1879, *Ibid.*, p. 655.—LINKO, 1905, Zool. Anzeiger, Bd. 28, p. 212.—BROWNE, 1903, Bergens Museums Aarbog, No. 4, p. 8, plate 1, fig. 1; plate 3, fig. 4.—HARTLAUB, 1907, Nordisches Plankton, Nr. 12, p. 47, fig. 44.
*Codonium princeps*, LEVINSEN, 1893, Vid. Meddel. Nat. For. Kjöbenhavn (5), Bd. 4, p. 143.—GRÖNBERG, 1898, Zoolog. Jahrb., Abth. Syst., Bd. 11, p. 458, taf. 27, figs. 1, 2.

Bell thin-walled and conical, about 25 to 40 mm. high, and 15 mm. wide. There is a short, conical, apical projection. There are 4 tentacles with long conical basal bulbs. The shafts of these tentacles are very contractile, three or four times as long as

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## Plate 6.

Figs. 1 and 1′. Hydroid of *Ectopleura dumortieri*. Dredged from a depth of 5 fathoms in Newport Harbor, Rhode Island, August, 1896. Figure 1, enlarged view; figure 1′, natural size.

Fig. 2. Medusa of *Ectopleura dumortieri*. Agassiz Laboratory, Newport, Rhode Island, July, 1892.

Fig. 3. *Sarsia angulata*. Turks Islands, Bahamas, January 20, 1893.

Fig. 4. *Protiara formosa*, male. Nassau Harbor, Bahamas, June, 1903.

Fig. 5. *Protiara formosa*, female. Tortugas, Florida, June 10, 1897.

Fig. 6. *Protiara formosa*, young medusa. Turks Islands, Bahamas, January 20, 1893.

Fig. 7. *Zanclea gemmosa*. Manubrium of the medusa shown in figure 5, plate 7.

Drawn from life, by the author.

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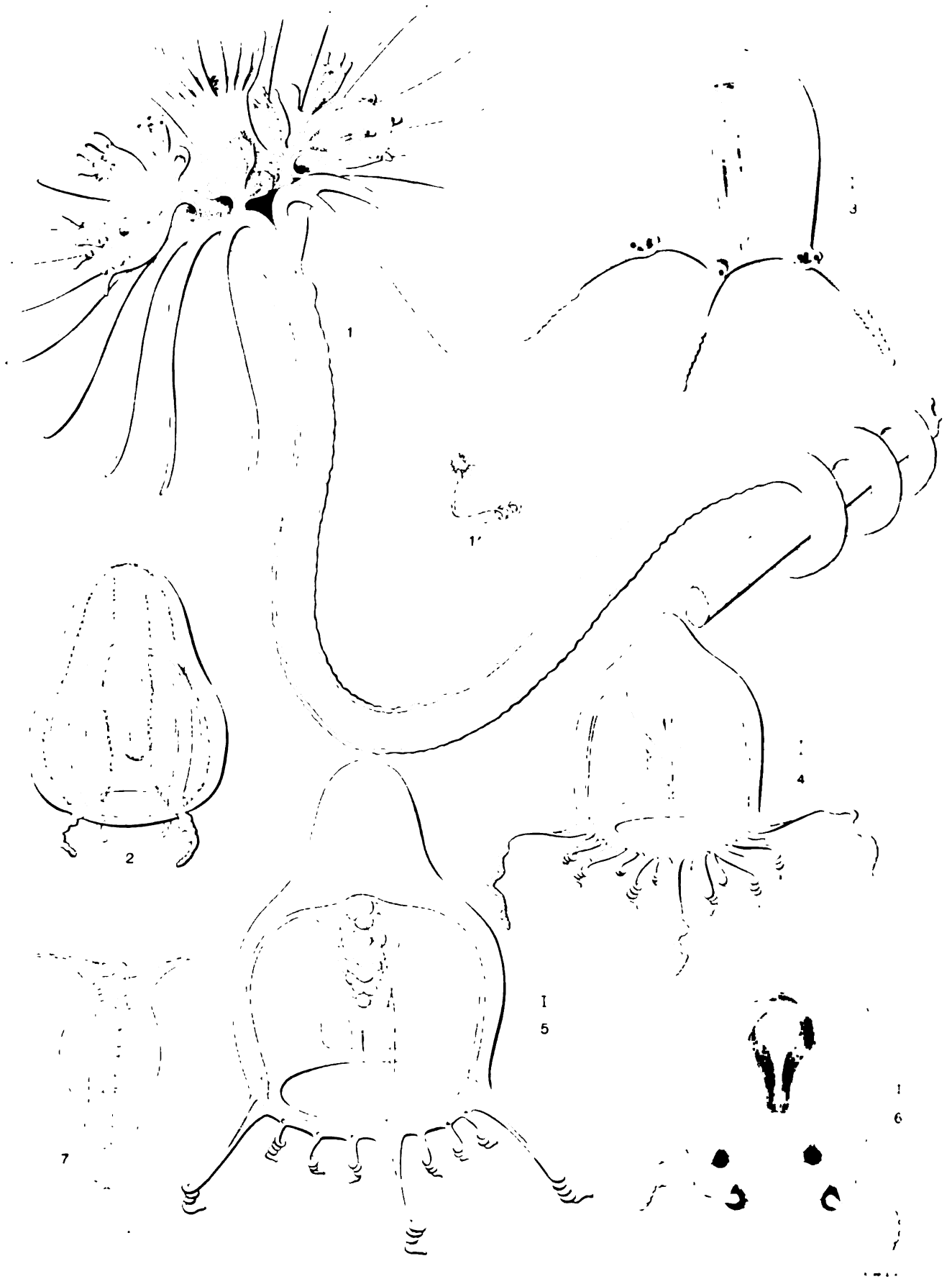


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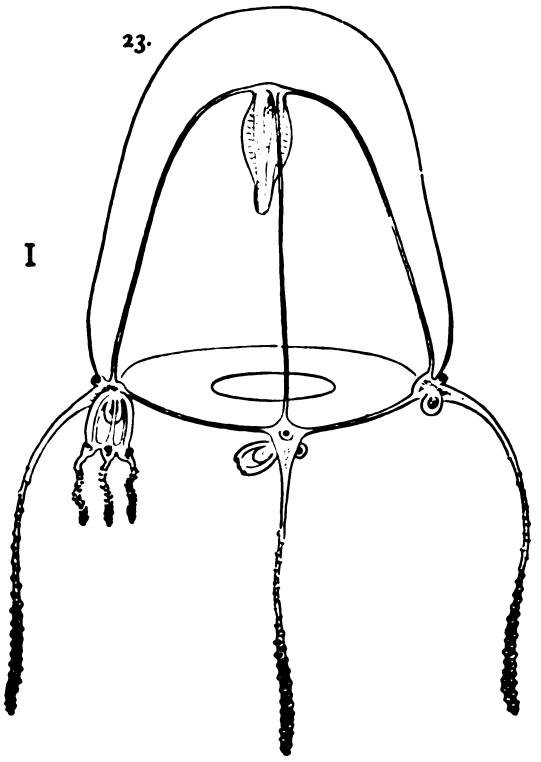
the bell-height, and covered with alternately arranged, wart-like clusters of nematocysts. A small ocellus is situated on the outer surface of each tentacle-bulb near the bell-margin. There are also 2 globular swellings, one on either side of each tentacle-bulb adjacent to bell-margin. The velum is narrow. There are 4 narrow, ragged-edged radial-canals and a slender circular canal. A short axial canal extends upward from the stomach-cavity into the gelatinous substance of the apical projection of the bell. The manubrium is long and cylindrical, and extends for about one-third of its length beyond the velar opening. The mouth is a simple opening without prominent lips. A single, short, tubular gonad is developed upon the sides of the manubrium. The manubrium, gonads, and tentacle-bulbs are purple. The ocelli are black.

This species is found off the coasts of Greenland and Spitzbergen, where it appears to be common. Grönberg, 1898, found it to be abundant at Spitzbergen, and Linko, 1905, found it to be common in Barents Sea, north of Lapland, Russia. It is the largest known *Sarsia*. Grönberg's description is based upon the study of living medusæ. Hartlaub also gives an excellent figure of the medusa, which we reproduce.



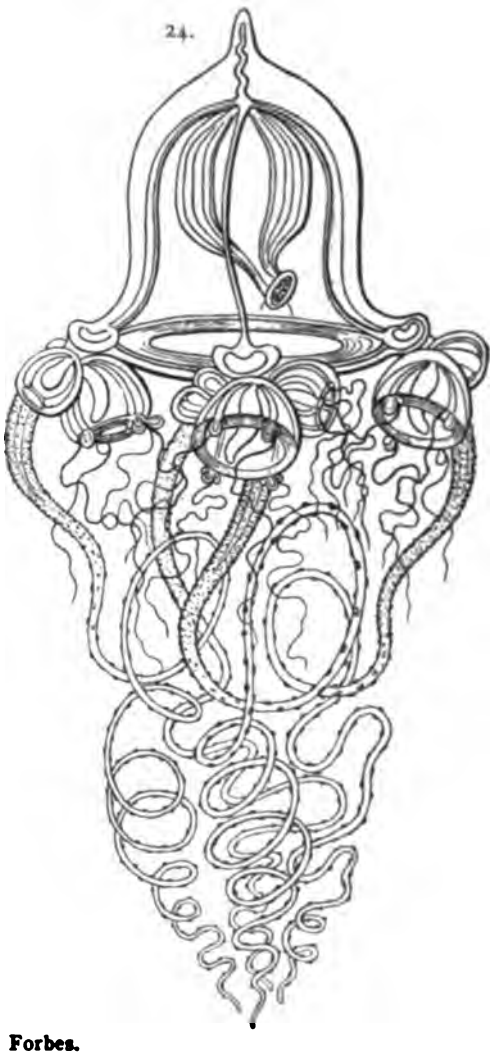




FIG. 23.—*Sarsia prolifera*, from life, by the author. Mousehole, Cornwall, England, Nov. 8, 1907.
FIG. 24.—*Sarsia codonophora*, after Haeckel, 1879.

**Sarsia prolifera Forbes.**

***Sarsia prolifera*, FORBES**, 1848, British Naked-eyed Medusæ, p. 59, plate 7, fig. 3.—BUSCH, 1851, Beobacht. wirbellos. Seeth., p. 1, taf. 1, figs. 1–6.—BEDOT, 1905, Revue Suisse de Zool., tome 13, p. 147 (all literature to 1850).—HARTLAUB, 1907, Nordisches Plankton, Nr. 12, p. 15, figs. 7, 8.
***Syncoryne prolifera*, ALLMAN**, 1871, Monog. Tubularian Hydroids, p. 83, fig. 38.
***Codonium codonophorum* + *Sarsia prolifer*, HAECKEL**, 1879, Syst. der Medusen, pp. 14, 18, taf. 1, fig. 3.
***Sarsia codonophora*, HAECKEL**, 1880, *Ibid.*, p. 655.

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In 1848 Forbes described this medusa from Penzance Bay, southern England, where it was abundant in August, 1846, and in 1879, and where I found it in November, 1907. Haeckel describes that which may prove to be the same species from the Mediterranean. The points of difference between the two medusæ will be brought out in the following description.

The bell is bell-shaped; in Forbes's medusa (fig. 23) 3 mm. wide and 4 high; in Haeckel's, (fig. 24), 8 mm. wide and 8 mm. high. Forbes's medusa lacks an apical projection, while Haeckel's has a short, conical, pointed apex. Also, in Forbes's medusa there was no axial canal above the stomach while in Haeckel's there was a narrow, axial vessel. Moreover, in Haeckel's medusa the margin of the bell flares outward, while in Forbes's specimen this is not the case.

It is well known to students of the Anthomedusæ that apical projections and axial canals are exceedingly variable, and may be absent or present in individuals of the same species. The outward flaring of the bell may be brought about through contraction. Haeckel's medusa appears to be merely a large, highly-colored specimen of *S. prolifera* Forbes.

The 4 marginal tentacles are 1 to 3 times as long as the bell-height. Their basal bulbs are large and tapering and about as wide as they are long. The tentacles taper gradually from base to shaft and are hollow. Clusters of 1 to 3 medusa-buds at a time are developed upon the tentacle-bulbs immediately below the bell-margin. When set free these medusæ are already producing another asexual generation of medusæ upon their tentacle-bulbs. The 4 radial-canals and ring-canal are straight and very narrow. The manubrium is spindle-shaped and nearly as long as the bell-height in Haeckel's, but not half so long in Forbes's medusa. The mouth is at the end of a narrow neck and is a simple, round opening. The stomach is encircled by the gonad, leaving the base and the throat-tube free.

Entoderm of tentacles and manubrium yellow to orange or sage-green. Each tentacle-bulb bears a prominent ectodermal brown-colored ocellus.

If it be true that Forbes's and Haeckel's forms are identical the medusa must range from southern England to the Mediterranean. It appears to be rare and its hydroid is unknown.

Allman, 1871 (p. 83, fig. 38), gives a figure of a medusa which closely resembles Forbes's *Sarsia prolifera*.

I found numerous specimens of this medusa off Mousehole, Mounts Bay, Cornwall, England, early in November, 1907. They accord well with the descriptions of Forbes and of Busch. The entoderm of the manubrium and tentacle-bulbs was sage-green; the tips of the tentacles light reddish-brown, and occasionally there was some reddish-brown pigment in the central entoderm of the stomach. The gonad encircled the stomach, leaving both ends of the manubrium free.

### Sarsia gemmifera Forbes.

*Sarsia gemmifera*, Forbes, 1848, British Naked-eyed Medusæ, p. 57, plate 7, fig. 2.—Chun, 1895, Bibliotheca Zoologica, Heft 19, pp. 4, 7, taf. 1, figs. 5, 6 (law of development of medusa-buds).—Browne, 1905, Proc. Roy. Soc. Edinburgh, vol. 25, p. 757.—Broch, 1905, Bergens Museums Aarbog, No. 11, p. 4.
*Codonium gemmiferum*+*Sarsia siphonophora*, Haeckel, 1879, Syst. der Medusen, pp. 15, 20, taf. 1, fig. 4.
*Codonium gemmiferum*, Bedot, 1905, Revue Suisse de Zool., tome 13, p. 132 (citation of literature to 1850).
*Purena gemmifera*, Hartlaub, 1907, Nordisches Plankton, Nr. 12, p. 58, figs. 54–58.

This medusa is found off the Atlantic coasts of Europe from Norway southward. Haeckel's *Sarsia "siphonophora"* from the Canary Islands is probably another name for the same species.

When young the medusa produces medusa-buds upon its manubrium. These arise in a spiral line, one following the other, down the sides of the manubrium. The oldest of the primary medusa-buds is nearest the base (uppermost) and the youngest nearest the mouth of the manubrium.

These primary medusa-buds are attached to the sides of the manubrium by short pedicels, and secondary and tertiary medusa-buds arise from the sides of these pedicels. Thus when the oldest (uppermost) original medusa-bud is set free, the secondary bud upon its pedicel remains attached to the manubrium and continues to develop, and when it in turn is set free the tertiary bud completes its development; this process takes place with each and every one of the series of buds.

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This successive freeing of the three series of buds produces various appearances at different periods of time, and in this manner we may explain the condition observed by Haeckel, 1879, in *Sarsia "siphonophora,"* where the buds appeared in two series, the oldest and largest of the upper series being at about the middle of the manubrium, while the oldest of the lower series was near the base of the stomach. Forbes, 1848 (plate 7, fig. 2 *e*), shows an intermediate stage in the budding process, and an early stage is shown by Chun, 1895 (fig. 25 A). The law of succession in development of the medusa-buds is clearly demonstrated by Chun. Both ectoderm and entoderm of the manubrium take an equal share in the formation of the budding medusæ.

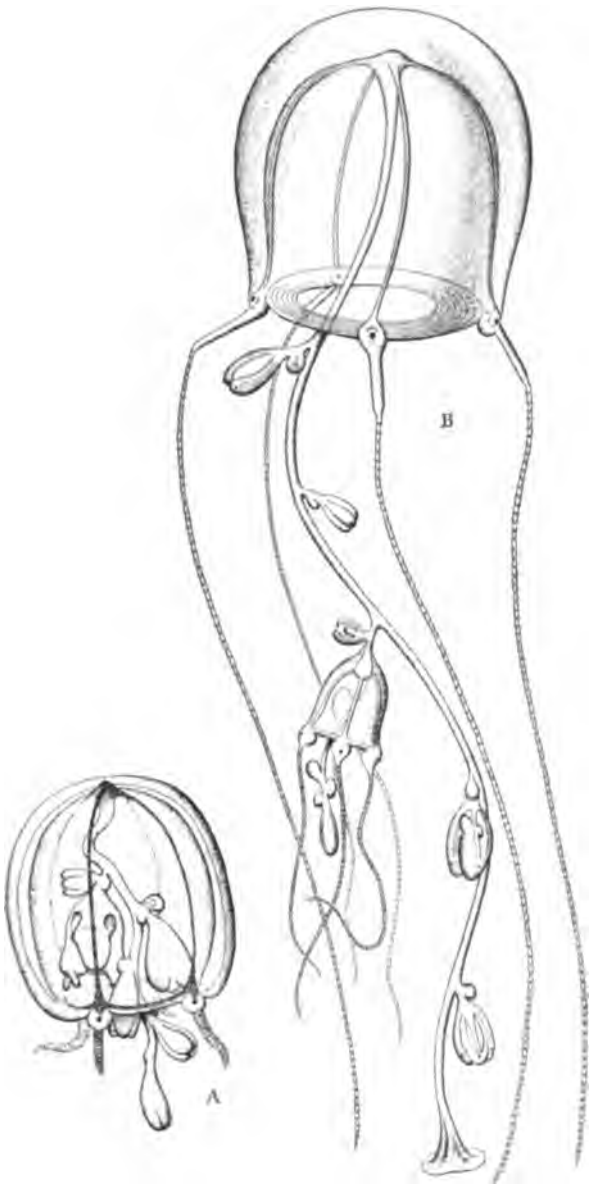


FIG. 25.—*Sarsia gemmifera*, showing law of budding. After Chun, in Bibliotheca Zoologica, Heft 19, taf. 1, 1895.
*A*, early; *B*, later stages of the process of budding.

For details of the character of the medusa, see tabular description of the medusæ of *Sarsia*.

Haeckel failed to observe the secondary and tertiary medusa-buds upon the pedicels of the budding medusæ in his *Sarsia siphonophora*, but this is probably due to an oversight, for in all other respects his medusa appears to be identical with *S. gemmifera* Forbes.

The gonad develops at the distal end of the manubrium after the budding process has ceased. Possibly there may be 2 or more ring-like gonads? (See Hartlaub, 1907.) If this be the case the medusa may be identical with *Dipurena fertilis* Metschnikoff, 1871.

**Sarsia hargitti.**

*Coryne producta*, HARGITT, 1902, American Naturalist, vol. 36, p. 550, fig. 3.
*Syncoryne producta*, HARGITT, 1904, Bulletin Bureau of Fisheries U. S., vol. 24, p. 30, plate 1, fig. 1.

A medusa called *Sarsia producta* is produced by budding from the hydroid of *Stauridia producta* Wright; and as this name takes precedence over that of Hargitt's medusa, it is necessary to rename the American species.

Bell 1.5 mm. high, and 1 mm. wide. Apex dome-like and rounded, and sides slightly compressed. Bell-cavity only about half as deep as the height of the bell. There are 4 long, equally developed tentacles with large basal bulbs, each with a large, ectodermal ocellus. Velum well developed. The 4 radial-canals are narrow, straight, and smooth-edged. The manubrium projects far beyond the velar opening, but is capable of great contraction. Its terminal part is bulb-like, while the basal portion is spindle-shaped and bears a whorl of medusiform gonads. The stomach gives rise to a blunt, dome-shaped aboral projection. The mouth is a simple, round opening. The basal part of the manubrium is orange, and its free end blue-green. The tentacle-bulbs are orange, edged with delicate green. The ocelli are black. A single specimen was found by Hargitt at Woods Hole, Massachusetts, on August

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10, 1901. It is distinguished from all other American species of *Sarsia* by its medusiform gonads borne upon the manubrium (text-fig. 26). It is not known whether medusæ are set free from the manubrium of the parent medusa.

### Sarsia flammea Hartlaub.

*Sarsia eximia* (in part), HAECKEL, 1879, Syst. der Medusen, p. 17.
*Sarsia flammea*, LINKO, 1905, Zool. Anzeiger, Bd. 28, p. 212.—HARTLAUB, 1907, Nordisches Plankton, Nr. 12, p. 12, figs. 4-6. (literature); 1903, Zool. Centralblatt, p. 22.

Bell high oval, 12 mm. high, 7 mm. wide, walls quite uniform and of moderate thickness. 4 tentacles, with well-developed, simple basal bulbs without ocelli. Tentacle tips slightly enlarged, club-like. Nematocysts over distal halves of tentacles arranged in prominent, broken rings. 4 slender, straight radial-canals. Manubrium thick, conical, spindle-shaped; only two-thirds as long as the depth of the bell-cavity. No axial-canal above the stomach. Gonad ring-like, encircling the manubrium from base to near the mouth. Stomach and tentacle-bulbs light fiery-red or orange.

From the Arctic Ocean.

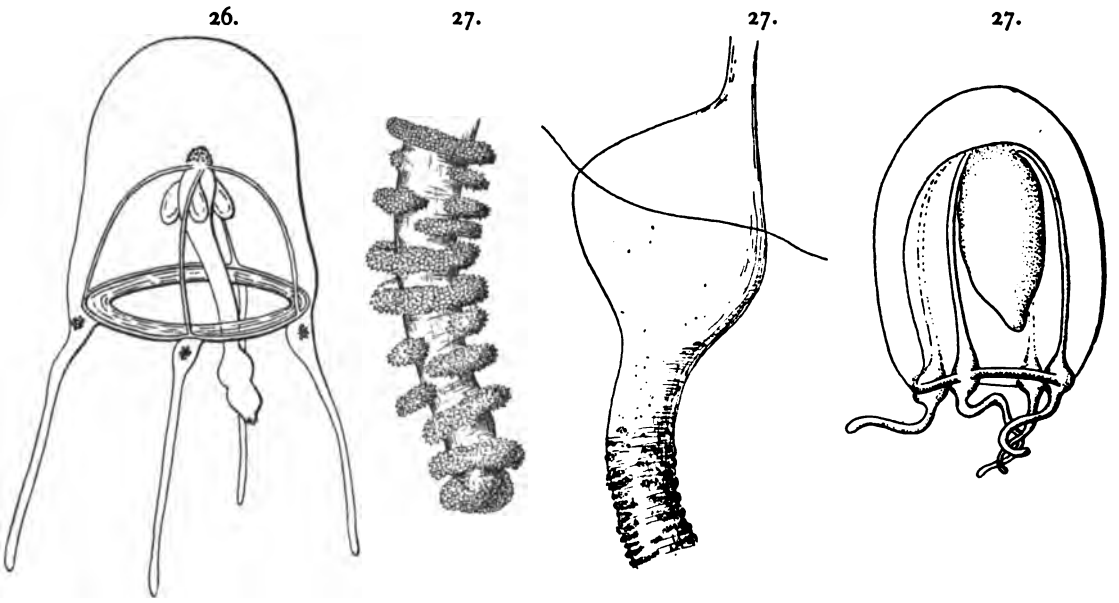


FIG. 26.—*Sarsia hargitti*, after Hargitt, in Bull. U. S. Bureau of Fisheries.
FIG. 27.—*Sarsia flammea*, after Hartlaub, in Nordisches Plankton. Showing arrangement of nematocyst clusters on tentacles.

Separated from *Sarsia eximia* and *S. brachygaster* by its lack of ocelli, and from *S. brachygaster* also by its smaller size. The best description is that of Hartlaub, 1907. Hydroid unknown. It is possible that this may be the medusa of the parasitic hydroid called *Hydrichthys mirus* Fewkes.

## Genus SARSIA, Subgenus STAURIDIOSARSIA nov. subgen.

*Stauridium*, HARTLAUB, 1895, Zeit. für wissen. Zool., Bd. 61, p. 142; 1907, Nordisches Plankton, Nr. 12, p. 52.

### CHARACTERS OF THE SUBGENUS.

Medusa similar to *Sarsia*, but the hydroid is *Stauridia*, not *Syncoryne*.

The name *Stauridia* should not be applied to these medusæ, for it was first used by Dujardin, 1843, to describe a hydroid which gives rise to a *Cladonema* medusa. It may be well to apply the new generic name *Stauridiosarsia* to hydroids which resemble *Stauridia*, but produce *Sarsia*-like medusæ.

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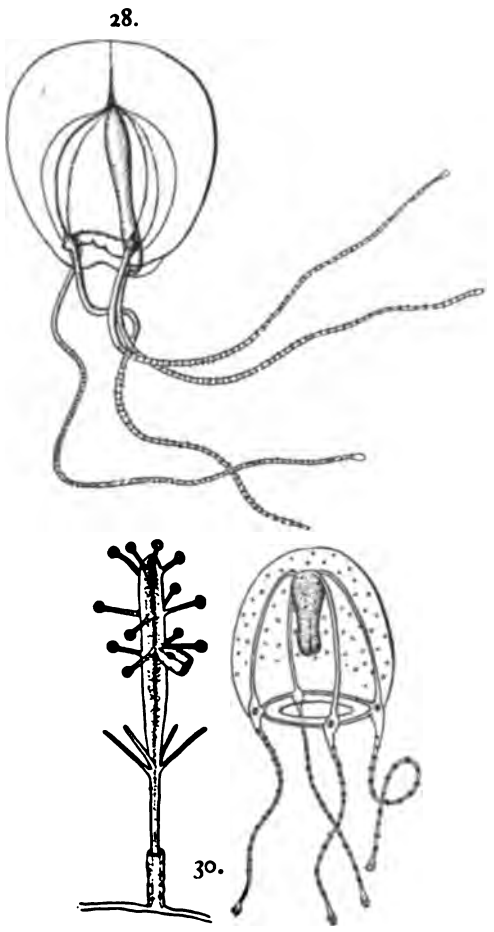
**Sarsia (Stauridiosarsia) producta.**

*Non Stauridie*, DUJARDIN, 1843, Ann. Sci. Naturelles, sér. 2, tom. 20, p. 370.
*Stauridia producta*, WRIGHT, 1858, Edinburgh New Philos. Journ., sér. 2, p. 283, plate 7, figs. 6–8.
*Stauridium productum*, HINCKS, 1868, British Hydroid Zoophytes, p. 68, plate 12, figs. 1, 1 *a*.—HARTLAUB, 1895, Zeit. für wissen. Zool., Bd. 61, p. 142, taf. 7, figs. 1–19; taf. 8, figs. 1–4; taf. 9, figs. 1, 2, 6; 1907, Nordisches Plankton, Nr. 12, p. 53, figs. 47–50.

The medusa is a *Sarsia*, but the hydroid is similar to *Stauridia*, and differs from *Syncoryne*, the hydroid of *Sarsia*, in that there is a basal circlet of simple, knobless tentacles; whereas all of the tentacles of *Syncoryne* terminate in knobs. The tentacles of *Stauridia*



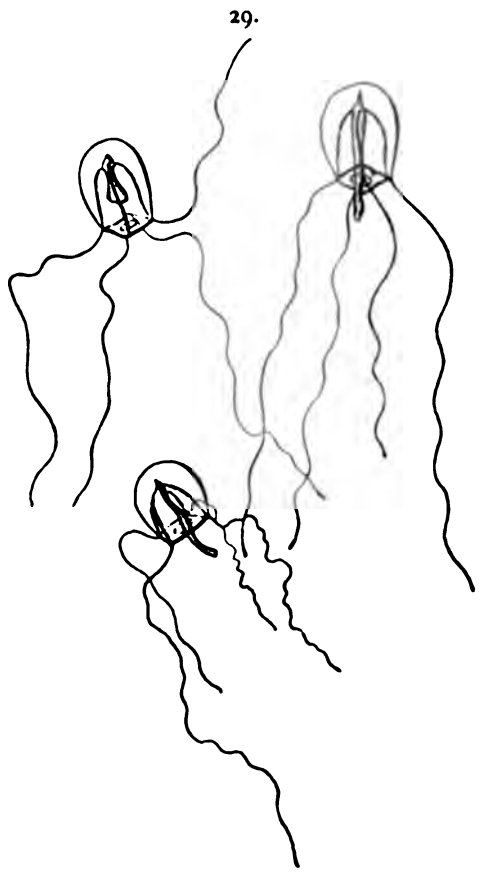




FIG. 28.—*Sarsia producta*, after Hartlaub, in Nordisches Plankton.
FIG. 29.—Medusæ of "*Sarsia producta*," natural size; after Hartlaub, in Nordisches Plankton.
FIG. 30.—"*Stauridium productum*," after Hincks, in British Hydroid Zoophytes. Hydroid and young medusa.

are of two sorts—the simple, short, stiff, tapering, knobless basal circlet, and above them several circlets of knobbed tentacles which arise from the sides of the hydranth. In *Syncoryne*, on the other hand, we find only knobbed tentacles. Thus two distinct genera of hydroids produce one and the same genus of medusa. Moreover, Dujardin, 1843, discovered that the hydroid which he called "*Stauridie*" produces the medusa *Cladonema radiatum*.

As the name *Stauridia* is preoccupied by Dujardin to designate the hydroid of *Cladonema* it can not be applied to the medusa of *Stauridia producta*. I therefore call the medusa of *Stauridia producta* by the name *Sarsia producta*, thus indicating its relationships when in the reproductive stage.

The medusa *Sarsia producta*, which is produced by the hydroid *Stauridia producta*, may be described as follows:

Bell 10 mm. high, 7 mm. wide, three-fourths-egg-shaped, with thick, gelatinous walls. 4 equally developed, radially placed tentacles; 1.5 times as long as the bell-height. Tentacle-

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bulbs large, each with an abaxial, ectodermal ocellus. Manubrium cylindrical, with about one-third of its length extending beyond the velar opening. A short, conical axial canal above the stomach. Gonad extends from the base to the distal end of the manubrium. No medusa-buds. Stomach brownish, gonads yellowish-white, tentacle-bulbs and axial canal red.

Helgoland and British coasts.

The hydroid has a thin-branching hydrorhiza, from which a number of club-shaped hydranths arise singly. These hydranths are each about 2 mm. long, with a proximal circlet of 4 to 6 short knobless tentacles, and above 2 or 3 more or less irregular circlets of large knobbed tentacles, usually with 4 tentacles in each circlet. The medusa-buds are produced from the sides of the hydranth above the basal circlet of tentacles. The hydranths are red. The hydroid and medusa are described in detail by Hartlaub, 1895.

The English and Helgoland forms differ considerably and they may be regarded as varieties one of the other (see Hartlaub, 1895, p. 157). The hydrorhiza of the English form anastomoses, while that of the Helgoland hydroid branches sparingly and does not anastomose. In the English form the knobbed tentacles are in whorls of 4 each, whereas in the Helgoland hydroid there are often 5, occasionally 6, tentacles in each whorl. In the English form the medusæ are said to arise from the bases of the tentacles, while in the Helgoland form they arise from the sides of the polypite between the knobless basal circlet and the lowest circlet of knobbed tentacles. Finally the Helgoland medusa has a large axial canal above the stomach, and this appears to be absent in the English medusa.

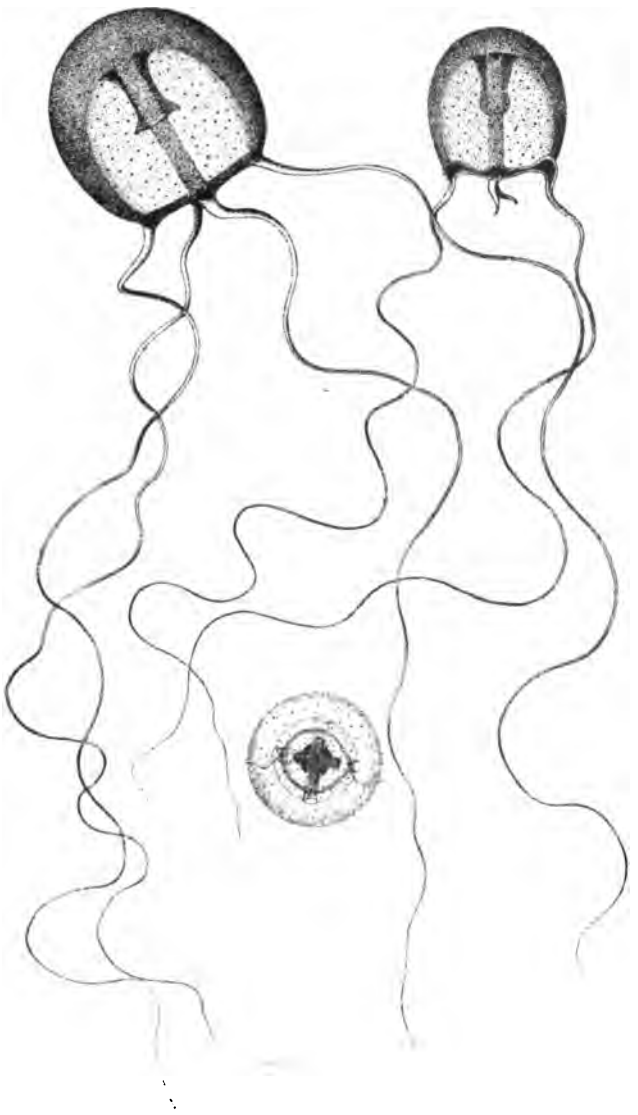

FIG. 31.—Young medusæ of *Hydrichthys mirus*, from Fewkes, in Bull. Museum Comp. Zool. at Harvard College.

**Genus HYDRICHTHYS Fewkes, 1888.**

*Hydrichthys*, FEWKES, 1888, Bull. Mus. Comp. Zool. at Harvard Coll., vol. 13, p. 224; 1888, Annals and Mag. Nat. Hist., ser. 6, vol. 1, p. 364.—HARGITT, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 32.

(?) *Plotocnide*, HARTLAUB, 1907, Nordisches Plankton, Nr. 12, p. 68.

GENERIC CHARACTERS.

The medusa resembles *Sarsia*, but is without ocelli upon the tentacle-bulbs. The mature medusa has not been determined. The hydroid is firmly attached to the side of a fish (*Seriola zonata*), and is probably parasitic, and degenerate in many respects. All of our knowledge of this remarkable form is derived from Fewkes, 1888. It differs widely from all other known forms of Tubularian hydroids.

In default of knowledge of the mature medusa we must remain in doubt concerning its true place in our classification. It is possible that *Sarsia flammea* Hartlaub may be the mature stage of this medusa.

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### Hydrichthys mirus Fewkes.

*Hydrichthys mirus*, Fewkes, 1888, Bull. Mus. Comp. Zool. at Harvard Coll., vol. 13, No. 7, pp. 224-232, plates 4, 5, 7 figs.; 1888, Ann. and Mag. Nat. Hist., ser. 6, vol. 1, p. 364; 1888, Proc. Boston Soc. Nat. Hist., vol. 23, p. 391.—Hargitt, 1904, Bulletin Bureau of Fisheries U. S., vol. 24, p. 32.

*Medusa*.—The adult medusa is undetermined, but may possibly be *Sarsia flammea*. The most advanced medusæ reared by Fewkes had the following characters: Bell rounded, without apical projection, and in form somewhat fuller than a hemisphere. Size (?) Outer surface of bell besprinkled with nematocysts. Bell-walls of moderate thickness, becoming thinner near the margin. There are 4 long, equally developed, radially situated tentacles, with long, tapering basal bulbs which lack ocelli. The 4 radial-canals are broad and straight and there is a simple, narrow, circular vessel. Manubrium cylindrical and about half as long as the depth of the bell-cavity. Mouth surrounded by 4 simple lips (?). The entoderm of the manubrium is yellow and orange, while that of the tentacle-bulbs is orange. Other parts of the medusa are colorless.

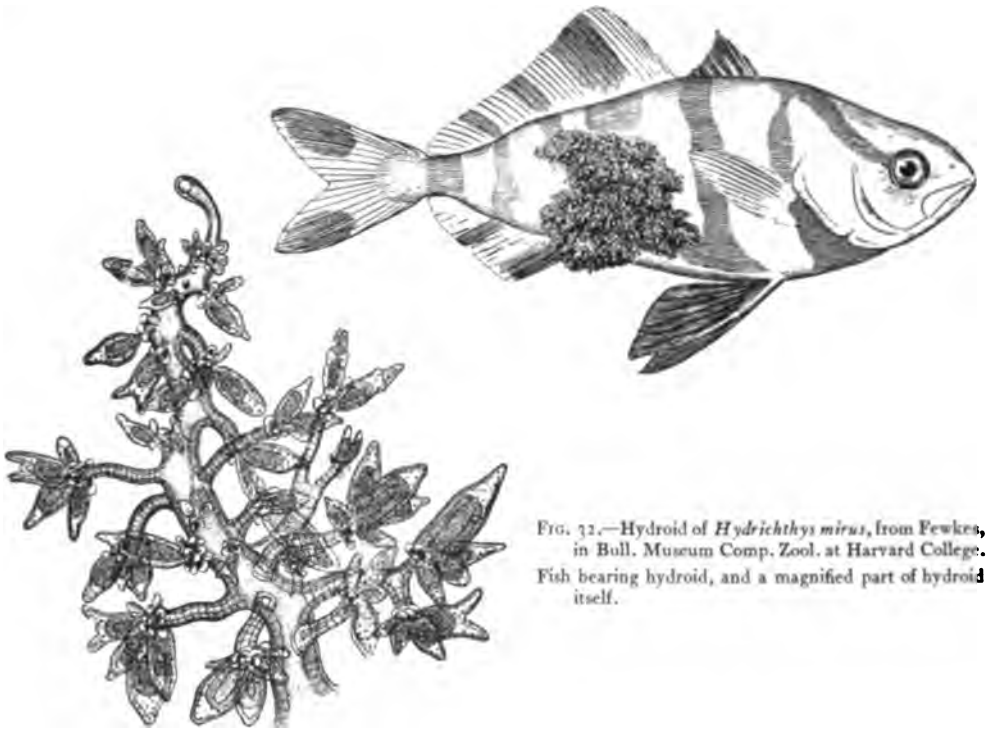

Fig. 32.—Hydroid of *Hydrichthys mirus*, from Fewkes, in Bull. Museum Comp. Zool. at Harvard College. Fish bearing hydroid, and a magnified part of hydroid itself.

*Young medusa*.—When first detached from the hydroid the medusa has but two diametrically opposite tentacles, and is more active in its movements than it is when it acquires four tentacles. This may, however, have been due to the injurious effects of confinement.

*Hydroid*.—The hydroid was found by Fewkes firmly attached to the side of a small fish, *Seriola zonata*. The hydroid colony arises from a basal network of tubes which forms a plate-like hydrorhiza embedded under the scales of the side of the fish, upon which it is probably a parasite. This basal network gives rise to tubular gonosomes and also to filiform, flask-shaped bodies, which recall the spiral zooids of *Hydractinia*, excepting that they appear to have a terminal mouth-opening.

The medusa-bearing gonosomes are conical and gradually taper from base to summit, where there may be a terminal opening. Irregularly distributed side branches arise from the main axis of the gonosome, and most of these give rise to medusa-buds. These side branches are usually simple, although occasionally they branch. They are hollow and in communication with the entodermal cavity of the main stem.

Clusters of medusa-buds in various stages of development arise from the ends of the branches. When set free these medusæ have but 2 tentacles, but later 2 more tentacles develop.

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All parts of the hydroid stock are highly contractile and the gonosomes and zooids are without chitinous sheaths.

The hydroid is colorless, but the medusa-buds are reddish and orange in color. The terminal parts of the flask-shaped zooids are also pigmented with reddish-orange.

A single stock of this hydroid was found by Fewkes in Narragansett Bay, Rhode Island, attached to a fish, *Seriola zonata*, in August, 1887. The fish was swimming near the surface and was apparently but little injured by the presence of the parasite.

It is interesting to observe that Alcock, 1892 (Annals and Mag. Nat. Hist., ser. 6, vol. 10, p. 207, 1 fig.), has discovered a hydroid of the genus *Stylactis* which is commensal upon a fish, *Minous inermis*. This hydroid, however, produces no medusæ.

### Genus EUCODONIUM Hartlaub.

*Eucodonium*, HARTLAUB, 1907, Nordisches Plankton, Nr. 12, p. 71.

The type species is *Eucodonium brownei* Hartlaub=*Dipurena* sp. Browne, from the British Coast.

GENERIC CHARACTERS.

Codonidæ with 4 equally developed, radially placed tentacles, each of which terminates in a distal knob. Stomach mounted upon a gelatinous peduncle. Hydroid unknown.

This genus is distinguished from *Sarsia* and *Slabberia* by the gelatinous peduncle upon which the stomach is placed. It is distinguished from *Dysmorphosa* by the terminal knobs of its tentacles and by its ring-like gonad.

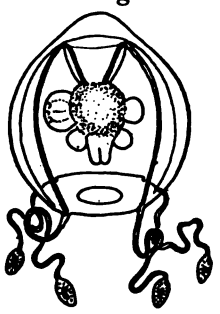

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FIG. 33.—*Eucodonium brownei*, after Browne, in Proc. Zool. Soc. London.

FIG. 34.—Hydroid of *Ectopleura dumortierii*, from Europe, after Hincks in British hydroid Zoophytes.

#### Eucodonium brownei Hartlaub.

*Dipurena* sp., BROWNE, 1896, Proc. Zool. Soc. London, p. 473, plate 16, fig. 2.
*Eucodonium brownei*, HARTLAUB, 1907, Nordisches Plankton, Nr. 12, p. 71, fig. 67.

Bell pyriform, thin-walled, 1 mm. wide. 4 radially placed, slender tentacles with small basal bulbs. Tentacles twice as long as the bell-height and with scattered nematocysts along their lengths, and each with a large, swollen, nematocyst-bearing knob at outer end of tentacle. No ocelli. Velum wide. 4 straight, narrow radial-canals.

Stomach short, mounted upon a conical, gelatinous peduncle. Mouth a simple, round opening at about the level of the velum. Medusa-buds arise from the sides of the stomach. The tentacle-bulbs are blackish, stomach and terminal knobs of the tentacles, dull dark-brown. Found at Plymouth, England, in September. Gonads(?) This is a young medusa, but we can not refer it to any known mature form.

### Genus ECTOPLEURA L. Agassiz, 1862 (sens. amend.).

*Tubularia dumortieri*, VAN BENEDEN, 1844, Mém. Acad. Belgique, tome 17, p. 50, plate 2.
*Ectopleura*, AGASSIZ, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 343.—AGASSIZ, A., 1865, North Amer. Acal., p. 191.—HAECKEL, 1879, Syst. der Medusen, p. 21.—FEWKES, 1882, Bull. Mus. Comp. Zool. at Harvard Coll., vol. 9, p. 295; 1883, Bull. Mus. Comp. Zool. at Harvard Coll., vol. 11, p. 85, plate 1, fig. 11.—ALLMAN, 1871, Monog. Tubul. Hydroids, p. 423.—HINCKS, 1868, British Hydroid Zooph., vol. 1, p. 123.—VANHÖFFEN, 1891, Zool. Anzeiger, p. 443.—HARTLAUB, 1894, Wissen. Meeresuntersuch. Komm. Deutsch. Meere Kiel, Abth. Helgoland (1), Bd. 1, p. 188; 1907, Nordisches Plankton, Nr. 12, p. 93.—BROWNE, 1905, Proc. Roy. Soc. Edinburgh, vol. 25, p. 748.

This genus was founded by L. Agassiz, 1862, the type species being *E. dumortieri* which was first described by Van Beneden, 1844, from the coast of Belgium under the name *Tubularia dumortieri*.

GENERIC CHARACTERS.

Codonidæ with 2 or 4 simple, unbranched tentacles situated at the bases of 2, or of all, of the 4 radial-canals. 8 longitudinal rows of nematocysts extend from the 4 tentacle-bulbs over the surface of the exumbrella to the apex of the bell. The manubrium is short and blunt, and the mouth is a simple, round opening. The hydroid is *Ectopleura*, and is closely related to *Tubularia*.

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The discovery of *Ectopleura pacifica* and *E. minerva* makes it necessary to amend the generic definition to include medusæ with 2 as well as with 4 tentacles.

*Ectopleura* is distinguished from *Zanclea* by its unbranched tentacles.

### Ectopleura dumortieri L. Agassiz.

Plate 5, figs. 4, 5; plate 6, figs. 1, 1′, 2.

LITERATURE RELATING TO THE EUROPEAN MEDUSA.

*Tubularia dumortieri*, VAN BENEDEN, 1844, Mém. Acad. Belgique, tome 17, p. 50, plate 2.—JOHNSTON, 1847, Hist. British Zoophytes, p. 50, plate 7, figs. 1, 2.
*Ectopleura dumortieri*, AGASSIZ, L. 1862, Cont. Nat. Hist. U. S., vol. 4, p. 342.
*Ectopleura dumortieri*, HINCKS, 1868, Hist. British Hydroid Zoophytes, p. 124.
*Ectopleura dumortieri*, ALLMAN, 1871–72, Monog. Tubularian Hydroids, p. 424.—BÖHM, 1879, Jena. Zeitschrift für Naturw., Bd. 12, p. 198, taf. 7, figs. 10–13.—HAECKEL, 1879, Syst. der Medusen, p. 22.
*Non Ectopleura dumortieri*, GRAEFFE, 1884, Arbeit. Zool. Inst. Wien, Bd. 5, p. 354.
*Ectopleura dumortieri*, HARTLAUB, 1894, Wissen. Meeresuntersuch. Komm. Meere Kiel, Helgoland (1), Bd. 1, p. 188.—BROWNE, 1905, Proc. Roy. Soc. Edinburgh, vol. 25, p. 748.
*Ectopleura dumortieri*, HARTLAUB, 1907, Nordisches Plankton, Nr. 12, p. 94, figs. 90, 91.
*Tubularia dumortieri*, BEDOT, 1905, Revue Suisse de Zool., tome 13, p. 126 (citation of literature, 1844–48).

LITERATURE RELATING TO THE AMERICAN MEDUSA.

*Ectopleura ochracea*, A. AGASSIZ, in L. Agassiz's 1862, Cont. Nat. Hist. U. S., vol. 4, p. 343.—AGASSIZ, A., 1865, North Amer. Acal., p. 191, figs. 320–323.—HAECKEL, 1879, Syst. der Medusen, p. 22.—FEWKES, 1882, Bull. Mus. Comp. Zool. at Harvard College., vol. 9, p. 295, plate 1, figs. 15, 16, 35, 36.—NUTTING, 1901, Bull. U. S. Fish Commission, vol. 19, p. 373, fig. 82.—HARGITT, 1904, Bulletin Bureau of Fisheries U. S., vol. 24, p. 32, plate 2, fig. 1.—AGASSIZ, A., and WOODWORTH, 1896, Bull. Museum Comp. Zool. at Harvard College., vol. 30, p. 149, plate 6, fig. 6 (photograph of the medusa).
*Ectopleura*, sp., HARGITT, 1908, Biol. Bulletin, vol. 14, p. 106, figs. 8–11.

The finding of the hydroid of our American *Ectopleura "ochracea"* leads me to believe that there are no specific differences between the European and American forms, and that both should be called *Ectopleura dumortieri*, this being the older name. Hartlaub, 1907, however, believes that *E. dumortieri* is smaller and has somewhat thicker bell-walls than *E. ochracea*, but our American medusa varies considerably in these respects, as do also specimens which I captured in the English channel in 1907.

The following description is based upon a study of large numbers of specimens obtained at Newport, Rhode Island, United States.

*Adult medusa.*—The bell is pyriform and is about 3 mm. high and 2.5 mm. wide. The gelatinous substance is very thick and is especially so at the aboral pole. 8 longitudinal lines of nematocyst-cells extend over the surface of the exumbrella from the basal bulbs of the 4 tentacles to the bell-apex, where they meet in a point. There are 4 equally developed, short tentacles with large basal bulbs. The outer surface of these tentacles is thickly covered with nematocyst-cells, and their distal ends are coiled in a close helix. Velum narrow. There are 4 narrow, straight radial-canals and a simple, narrow, circular tube. The manubrium is fusiform and extends not more than two-thirds the distance from the inner apex of the bell-cavity to the level of the velar opening. There is no peduncle, and the mouth is a simple round opening, the edge of which is armed with clusters of nematocysts. A short, blunt, axial canal is often seen projecting upward from the stomach into the gelatinous substance of the apex of the bell. The gonads are developed in the ectoderm encircling the stomach. In brilliant specimens the tentacle-bulbs are yellow with a red core.

The middle region of the entoderm of the manubrium is lilac-colored, the upper part delicate yellow, and the lower end red or pink, but very often the medusa is dull purple or dull brownish-purple.

*Hydroid.*—The hydroid shown in plate 6, figs. 1, 1′ was found in August, in Newport Harbor, Rhode Island, at a depth of about 10 fathoms. It is a Tubularian belonging to the family Hyboconidæ Allman, and is apparently identical with *Tubularia* (*Ectopleura*) *dumortieri* of Van Beneden, 1844.

The hydroid is about 25 mm. in length, and was found clinging to the stems of *Obelia*. The stems of the *Ectopleura* are isolated. Most of them are simple and unbranched, but occasionally they give rise each to a single side branch near the lower end. The lower end of the *Ectopleura* is coiled around the stem of the *Obelia* in a close helix. The stem of the *Ectopleura*



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is covered by a delicate investment of perisarc which displays a number of small annulations near the upper end. The stem terminates in a single, large polypite, which is broad and flask-shaped. The mouth is situated at the extremity of a tubular proboscis, and is surrounded by a single verticil of about 16 short, flexible tentacles. In addition to these there is another verticil of about 24 long, fleshy tentacles at the wide base of the polypite. These long tentacles are not very contractile. They taper gradually from base to end. The tentacles at the base of the polypite are about three times as long as are those surrounding the mouth. The medusa-buds are borne in numbers on short, branching peduncles which arise from the sides of the polypite in a zone immediately above the basal tentacles. When set free each medusa has 4 short tentacles, and the 8 longitudinal rows of nematocysts upon the exumbrella are well developed. The ectoderm of the stem of the hydroid is a delicate, fleshy-yellow and the entodermal core is flesh-colored pink. The entoderm of the polypite is fleshy-pink and yellow.

This medusa is very common throughout the summer in Narragansett and Buzzard's Bays, and on the southern coast of New England east of New Haven, Connecticut. It has not been taken north of Cape Cod. It has been recorded from Beaufort, North Carolina, and I found it in Winyah Bay, South Carolina, but it has not been taken either at Charleston, South Carolina, or at the Tortugas, Florida. It is found in the English Channel and off the North Sea coasts of England, Scotland, Holland, and Germany. As in America, it appears to be abundant only in a few localities. I found several specimens of this medusa in the English Channel in October, 1907, and they appear to be identical in all respects with medusæ from the southern coast of New England, in America. Hargitt has recently discovered the hydroid at Woods Hole, Massachusetts.

### Ectopleura minerva Mayer.

Plate 5, fig. 3.

*Ectopleura, sp.*, Fewkes, 1883, Bull. Mus. Comp. Zool. at Harvard College, vol. 11, p. 85, plate 1, fig. 11.
*Ectopleura minerva*, Mayer, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 38, p. 31, plate 16, fig. 38; plate 37, fig. 125.
(?) *Ectopleura dumortieri*, Graeffe, 1884, Arbeit. Zool. Inst. Wien, Bd. 5, p. 354.

This medusa has 2 well-developed and 2 rudimentary tentacles, instead of 4 equally developed tentacles as in the northern species of *Ectopleura*.

Bell 2.5 mm. high and pear-shaped, with a well-developed apical projection. Bell-walls of moderate thickness. 8 rows of nematocyst-cells extend from the 4 tentacle-bulbs to the apex of the bell. There are 2 well-developed tentacles and 2 small tentacle-bulbs. There are 6 to 9 separate wart-like swellings upon the outer side of each of the 2 large tentacles. These swellings are crowded with nematocysts. Basal bulbs of tentacles small and without ocelli. There are 4 straight, narrow radial-canals and a slender, circular vessel. The velum is well-developed. Manubrium pear-shaped and about two-thirds as long as the depth of the bell-cavity. It is wider near the middle than at either end. The mouth is a simple, round opening. A simple, short, conical style-canal extends upward into the apical projection of the bell.

The entoderm of the manubrium and tentacles is a delicate purple, while the supporting lamella of the bell is of a decided green. There are a large number of brilliant yellow spots in the entoderm of the radial-canals and tentacle-bulbs.

This form is rare at Tortugas, Florida. It was found by Fewkes at the Bermudas. A similar medusa was described by Graeffe, 1884, from Trieste, Mediterranean, under the name *Ectopleura dumortieri*.

*Ectopleura minerva* may prove to be identical with *E. pacifica* Thornely, from the tropical Pacific.

### Ectopleura pacifica Thornely.

*Ectopleura pacifica*, Thornely, 1900, Zool. Results, A. Willey, Part 4, p. 452, plate 44, figs. 1, 1*a*, Cambridge, England.

*Hydroid.*—Stems simple, unringed, diminishing in width toward the base, and 20 mm. high, rising from a creeping stolon which connects the colony. Some of the stems give rise to stolons near their bases. The polypite is abruptly marked off from the supporting stalk.

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There are two verticils of tentacles of 18 to 20 each. The basal tentacles are very long, and the oral ones are short, and with knob-shaped (?) ends. The medusa-buds are borne in clusters of from 7 to 9 on branched peduncles, which arise from the body of the polypite between the two verticils of tentacles. When about to be set free each medusa-bud has 2 well-developed tentacles, thus resembling *E. minerva* of Tortugas, Florida. *E. pacifica* is common in Blanche Bay, New Britain, South Pacific. It is attached to floats, fish-baskets, etc. Color (?) This hydroid may be identical with *E. minerva* of the tropical Atlantic coast of North America.

### Genus CORYNITIS McCrady, 1857.

*Corynitis*, McCrady, 1857, Gymn. Charleston Harbor, Proc. Elliott Soc. Charleston, p. 29.—Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 340.—Agassiz, A., 1865, North Amer. Acal., p. 183.—Allman, 1871, Monog. Tubularian Hydroids, p. 286.
*Corynetes*, Haeckel, 1879, Syst. der Medusen, p. 48.
*Plotocnide*, Wagner, 1885, Wirbellosen Weissen Meeres, p. 74.
*Corynetes*, Vanhöffen, 1891, Zool. Anzeiger, Bd. 14, p. 442.
*Non Corynitis*, Murbach, 1899, Quart. Journ. Mic. Sci., New Series, vol. 42, p. 354 (this is *Zanclea*).
(?) *Modeeria, Protiara* (young medusa), Haeckel, 1879, Syst. der Medusen, p. 47.
(?) *Tiaricodon*, Browne, 1902, Annals and Mag. Nat. Hist., ser. 7, vol. 9, p. 276.
*Non Corynitis*, Nutting, 1901, Bull. U. S. Fish Commission for 1899, p. 372 (this is *Zanclea*).
*Non Corynitis*, Hargitt, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 42 (this is *Zanclea*).
*Syncoryne linvillei* (hydroid), Hargitt, 1904, Biological Bulletin, Woods Hole, vol. 7, p. 251, 1 fig.; *Ibid.*, 1908, vol. 14, p. 101, fig. 1.

The type species of this genus is *Corynitis agassizii* described by McCrady from Charleston Harbor, South Carolina.

#### GENERIC CHARACTERS.

Codonidæ in which the manubrium is cruciform in cross-section. The 4 tentacle-bulbs have large, abaxial, ectodermal ocelli. The tentacles are unbranched and terminate each in a knob-like cluster of nematocysts, and the shaft of each tentacle is besprinkled with wart-like clusters of nematocysts. There are 8 irregular, longitudinal rows of nematocysts upon the exumbrella, 4 of these being radial and 4 interradial in position. The hydroid is *Syncoryne*.

McCrady, 1857, and L. Agassiz, 1862, described a hydroid which they ascribed to *Corynitis agassizii*, but which is certainly very close to, if not identical with, the hydroid generation of *Zanclea*. Hargitt, on the other hand, has discovered that *Corynitis agassizii* arises from a *Syncoryne*-like hydroid which he called *S. linvillei*.

In the medusæ of *Ectopleura*, *Zanclea*, and *Corynitis* there are longitudinal patches of nematocysts upon the exumbrella. In *Corynitis agassizii* the tentacles terminate each in a knob-like club. In *Zanclea dichotoma* they terminate in a similar manner, but in addition they give rise to side branches all arising from the aboral side of the tentacles, and each terminating in a knob-like cluster of nematocysts. In *Corynitis*, on the other hand, there are merely scattered wart-like clusters of nematocysts over the shaft of each tentacle. It is possible that *Zanclea* arose from some *Corynitis*-like medusa; certainly *Zancleopsis dichotoma* is intermediate in many characters between *Corynitis agassizii* and *Zanclea gemmosa*.

However doubtful the relationship may be between *Corynitis* and the *Cladonemine*, there can be no doubt of its close relationship to *Slabberia* and *Sarsia*. The young medusa of *Corynitis* can not be distinguished from the young of *Slabberia*.

Murbach and Nutting are mistaken in their *Corynitis* medusa, which is clearly *Gemmaria* (*Zanclea*). The medusa of *Corynitis* is so clearly described and figured by McCrady as to be unmistakable. I have frequently taken it in Charleston Harbor, South Carolina, where McCrady discovered it, and his figure and description enable one instantly to recognize it. It lacks the feathered tentacles of *Gemmaria* (*Zanclea*).

Hargitt, 1904, at first followed Murbach in this erroneous identification of *Corynitis*, but his final discovery of the *Syncoryne*-like hydroid of *Corynitis* enabled him not only to correct the mistake, but to establish the close relationship between *Corynitis* and other *Sarsia*-like medusæ.

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### Corynitis agassizii McCrady.

Plate 5, fig. 2.

*Corynitis agassizii*, McCrady, 1857, Gymn. Charleston Harbor, p. 30, plate 9, figs. 3–8.—Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 340.—Agassiz, A., 1865, North Amer. Acal., p. 183.—Allman, 1871, Monog. Tubul. Hydroids, p. 287.
*Corynetes agassizii*, Haeckel, 1879, Syst. der Medusen, p. 49.
(?) *Corynetes agassizii*, Maas, 1893, Ergeb. der Plankton Exped., Bd. 2, K. c., p. 67.
*Non Halocharis spiralis* (hydroid), Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 239, plate 20, figs. 10–10 *c*.
*Coryne agassizii* (hydroid), McCrady, 1857, Gymn. Charleston Harbor, pp. 29, 32.
*Non Corynitis agassizii*, Hargitt, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 42 (this is *Gemmaria=Zanclea*).
*Non Corynitis agassizii*, Nutting, 1901, Bull. U. S. Fish Commission for 1899, vol. 19, p. 372, fig. 79 (this is *Gemmaria=Zanclea*).
*Non Corynitis agassizii*, Murbach, 1899, Quart. Journ. Microscop. Sci., New Ser., vol. 42, p. 354 (this is *Gemmaria=Zanclea*).
*Syncoryne linvillei* (hydroid), Hargitt, 1904, Biological Bulletin Woods Hole, vol. 7, p. 251, 1 fig; 1908, *Ibid.*, p. 101, fig. 1.

*Adult medusa.*—Bell miter-shaped and about 2.5 mm. in height. 8 longitudinal rows of irregularly scattered nematocyst-cells are found upon the sides of the exumbrella immediately above the circular canal. 4 of these are situated above the tentacles and 4 are interradial in position. The radially situated rows of nematocysts are longer than the interradial. There are 4 straight, stiff tentacles, which are about three-quarters as long as the bell-diameter. Each tentacle terminates in a large, knob-shaped swelling, the outer surface of which is thickly covered with nematocysts. The entodermal core of this swelling is hollow and its lumen is placed in communication with the gastrovascular system of the medusa by means of a slender entodermal canal which extends through the entire length of the tentacle. Wart-like clusters of nematocysts are scattered over the shaft of each tentacle. The basal bulbs are large and hollow, and each one contains a single ectodermal ocellus upon the outer side. Velum well-developed. There are 4 straight radial-canals and a narrow circular tube. The large conical apex of the bell is hollow and in direct communication with the stomach of the medusa. The manubrium is very large and swollen and fills the greater part of the bell-cavity. It extends almost to the level of the velar opening. The mouth is situated at the extremity of a short œsophagus. It is without prominent lips. The gonads occupy the greatly swollen sides of the stomach, and their outer surfaces are smooth. 4 deep, interradial furrows extend down the sides of the stomach, so that the manubrium is cruciform in cross-section. The entoderm of the basal bulbs of the tentacles is strawberry-red and that of the terminal knobs of the tentacles is orange-yellow flecked with red-colored pigment-granules. The manubrium is dull yellow streaked with strawberry-red and the entoderm of the radial-canals is faint yellow. The ocelli are dark-brown or orange.

Fig. 35.—Hydroid of *Corynitis*, after Hargitt, 1908, Biological Bulletin.

The hydroid is a *Syncoryne*, and is described by Hargitt. It grows in tufts which are sparingly branched and 15 to 30 mm. high. The hydranths are vasiform with cone-shaped proboscis. There are 15 to 30 tentacles distributed over the proximal third of the body of the hydranth. These tentacles terminate each in a knob-like free end. The perisarc is plain or with only a slight annulation. The hydrorhiza is reticulated in a loose network. The medusa-buds are borne upon the body of the hydranth, usually in small clusters at the bases of the tentacles, each cluster supported upon a single peduncle, the terminal specimen always maturing first. The medusæ, while still attached to the hydroid, have 2 well-developed, diametrically opposed, club-shaped tentacles and 2 small tentacle-buds. There are no ocelli. There are 4 radial-canals and the umbrella is bell-shaped. In formalin the hydroid is pale-yellowish, hydranth somewhat brownish, and gonophores reddish-brown or pink. This hydroid was found by Dr. Henry R. Linville growing upon rocks and piles under "Milldam Bridge" west of Shelter Island, Long Island Sound, New York. It is described by Hargitt from preserved material under the name *Syncoryne linvillei*. When set free the medusæ have only 2 tentacles and 2 small, basal bulbs.

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This medusa is very abundant in Charleston Harbor, South Carolina, during the summer and early autumn. It is also common in Great Peconic Bay, Long Island Sound, and at Woods Hole, in September. It has not been taken north of Cape Cod, Massachusetts, or at the Tortugas, Florida.

### Corynitis arcuata Haeckel.

*Corynetes arcuata*, HAECKEL, 1879, Syst. der Medusen, p. 49.

This variety, or species, is distinguished from *Corynitis agassizii* by its long, narrow bell, about twice as high as it is broad, and by its long, thin tentacles. The nematocysts upon the tentacles are smaller and more numerous than they are upon the tentacles of *C. agassizii*. The stomach is small and bell-shaped, with a short œsophagus which does not extend beyond the velar opening. Haeckel gives the bell-height as 6 and the breadth 10 mm.; but judging from his description of the medusa these figures must be erroneously stated and should be reversed.

It is found off the coast of Brazil. Haeckel describes it from a single preserved specimen.

### Corynitis (?) cœrulea.

*Tiaricodon cæruleus*, BROWNE, 1902, Annals Mag. Nat. Hist., ser. 7, vol. 9, p. 276.

This medusa is very briefly described by Browne, without figures. The gonads are not radially separated and there is nothing in Browne's description to indicate that the medusa belongs to the Tiarinæ. Its characters appear to be those of *Corynitis*.

Umbrella bell-shaped, 25 mm. high, 24 mm. wide, with a rounded summit. The exumbrella is smooth without nematocysts. 4 fairly stout, radially situated tentacles tapering to a point. Their basal bulbs are large and cylindrical, a little longer than broad, and with an ocellus. Velum narrow. The manubrium is placed upon a short, broad peduncle. It is quadrangular with 4 perradial folded lips about as wide as the stomach. The mouth extends nearly to the level of the velar opening. The gonads surround the stomach and extend outward over the peduncle as 4 perradial lobes. Found at Stanley Harbor, Falkland Islands. The young medusa resembles a *Sarsia*. The color is not stated by Browne.

## Genus SLABBERIA Forbes, 1846.

*Slabberia*, FORBES, 1846, Ann. and Mag. Nat. Hist., vol. 18, p. 286; 1848, British Naked-eyed Medusæ, p. 53.—FORBES and GOODSIR, 1853, Tran. Roy. Soc. Edinburgh, vol. 20, p. 311.
*Dipurena*, MCCRADY, 1857, Proc. Elliott Society, Charleston, p. 135.—AGASSIZ, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 341.—AGASSIZ, A., 1865, North Amer. Acal., p. 180.
*Dipurena+Bathycodon*, HAECKEL, 1879, Syst. der Medusen, pp. 23, 26.
*Dipurena*, BROWNE, 1898, Proc. Zool. Soc. London for 1897, p. 816.
*Dipurena+Dipurella*, HARGITT, 1904, Bulletin Bureau of Fisheries U. S., vol. 24, pp. 30, 31.
*Dipurena*, VANHÖFFEN, 1891, Zool. Anzeiger, Bd. 14, p. 442.—BROWNE, 1905, Report on Pearl Oyster Fisheries, Gulf of Manaar, Supplementary Report 27, Roy. Soc. London, p. 133.
*Slabberia* (in part), AGASSIZ, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 341.
*Slabberia* (in part), HAECKEL, 1879, Syst. der Medusen, p. 23.
*Purena+Slabberia*, HARTLAUB, 1907, Nordisches Plankton, Nr. 12, pp. 55, 62.

In 1846 Forbes described a medusa under the name *Slabberia halterata*. It had 4 radial-canals with a swollen region upon each canal. In other respects it resembled *Sarsia*, excepting that each of the 4 tentacles terminated in a knob-like extremity. Forbes believed the swelling on the radial-canals to be gonads and established the genus *Slabberia* with the following designation: "Umbrella campanulate; ovaries four, linear, in the course of the four simple, gastrovascular canals; peduncle proboscidiform, highly extensile, oral orifice circular; a marginal tentacle springing from an ocellated bulb and terminating in a colored globular body, placed opposite each of the gastrovascular canals."

Forbes laid especial stress upon the "gonads" upon the radial-canals, and he believed the manubrium to be simple and tubular, and failed to find collar-like swellings upon it. Haeckel, 1879, p. 241, and Browne, 1898, p. 816, find, however, that the gonads in Forbes's medusa are developed in separated ring-like annuli upon the manubrium and Browne, who sectioned the supposed "gonads," finds that they contain entodermal cells crowded with small nuclei, and they are doubtless mere glands similar to those seen upon the radial-canals of many Antho-

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*Tabular Description of the Medusæ of Slabberia.*

| | Slabberia halterata Forbes, 1846.[1] | S. strangulata = Dipurena strangulata McCrady, 1857.[2] | S. strangulata var. fragilis Mayer.[3] | S. catenata Forbes, 1853 = Dipurena dolichogasta Haeckel, 1879, = D. picta Mayer, 1900 = Sarsia clavata Keferstein, 1862.[4] | S. ophiogaster = Dipurena ophiogaster Haeckel, 1879. = Sarsia strangulata Allman, 1871.[5] | S. pyramis = Bathycodon pyramis Haeckel, 1879.[6] |
|---|---|---|---|---|---|---|
| Shape and size of bell in mm. | Ellipsoidal. 8 high, 6 wide. | Ellipsoidal to hemispherical. 2 to 4 high, 4 to 3.3 wide. | Ellipsoidal. 4 high, 3.5 wide. | Ellipsoidal. 2.4 high, 1.6 wide. | Globular. 5 high, 4 wide. | Pyramidal. 4-sided. 5 high, 5 wide. 4 lines of nettle-cells extended up exumbrella in 4 principal radii. |
| Character of the 4 tentacle-bulbs. | Large with an abaxial ocellus. | As in S. halterata. | Very small. | As in S. halterata. | Poorly developed, with abaxial ocelli. | Ocelli? |
| Length of each tentacle in terms of bell-radius ($r$). | $2r$ | $1.5r$, quite thick. | $2r$ very slender. | $2r\pm$ | $2r+$ | $4r+$ |
| Number and position of nettle-warts on each tentacle. | 1 large, terminal, club-shaped knob. 1 to 2 rings at base of knob. | Single knob-like end and with nettle-warts on shaft of each tentacle. | As in S. strangulata. | Proximal halves of tentacles smooth. Outer halves ringed with 15 to 30 nematocyst swellings. | Tapering. Outer parts thickly covered with prominent partial rings and spirals containing nettle-cells. | Each tentacle terminates in "suctorial cup." |
| Character of the 4 radial-canals. | Narrow, straight, each with swollen (glandular?) enlargement at two-thirds length of canal above margin. | Narrow, straight, without "glandular" swellings. | As in S. strangulata. | As in S. strangulata. | As in S. strangulata. | Edges of radial-canals lined with gland-cells. |
| Length of manubrium in terms of bell-radius ($r$). | 4 to 7 $r$. | 4 to 7 $r$. | $2r$ | 4 to 7 $r$. | 8 to 12 $r$. | $4r+$ |
| Number of ring-like gonads which encircle manubrium. | 2 or 3. 1 or 2 small genital rings below middle, and a longer one near outer end of manubrium. | 2. Small ring near middle, and longer outer ring. | 2. As in S. strangulata. | 2 or 3 as in S. halterata. Preceding development of gonads medusa-buds are borne on manubrium (see text). | 4 to 6 short, swollen, separated by short intervals. | 8 separated rings. |
| Color. | Entoderm of tentacle-bulbs and tentacle-knobs reddish-brown; of manubrium yellowish-brown. Ocelli black. | Variable shades of yellow, red, and green. Ocelli black. | Dull-yellow entoderm of stomach and tentacles. Ocelli black. | Stomach yellow or red. Gonads and tentacles light-red. Mouth, tentacle-bulbs, and apex of stomach bright-yellow, red, and purple. Ocelli deep-purple brown. | As in S. catenata. Ocelli black. | Stomach canals and tentacles light-green. Mouth, tentacle-bulbs and terminal "anchors" darker green. |
| Where found. | Southern coasts of England and Ireland. Rare. | Coast of United States from South Carolina to Cape Cod. | Tortugas, Maldive Islands, Indian Ocean, Bigelow. | West coast of Scotland to Mediterranean. | Southern coasts of England and Ireland to Mediterranean. (?) Ceylon (Browne). | Mediterranean, Corfu; from depth of 20 fathoms, April, 1877, Haeckel. |

[1] Distinguished by 4 small, isolated (glandular?) bodies upon its 4 radial-canals. Hartlaub, 1907, believes these to be gonads which become mature only in old medusæ.
[2] Distinguished by its quite thick tentacles, each ending in a single, knob-like cluster of nematocysts.
[3] Separated from *S. strangulata* only by its long, slender tentacles and uniform dull-yellow color.
[4] Hydroid a *Syncoryne*. Medusa distinguished by numerous total or partial rings of nettling cells which are developed over outer halves of tentacles. When young medusa-buds are borne on manubrium of free medusa.
[5] Is this a fully developed, mature condition of *S. catenata* (?).
[6] Distinguished by terminal "suctorial cups" on its tentacles and numerous glands (?) which line radial-canals.

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medusæ. On the other hand, Browne found the gonads upon the manubrium, arranged in 2 or more isolated ring-like swellings. In 1853 Forbes and Goodsir describe another species of *Slabberia*, *S. catenata*, which lacks glands upon its radial-canals, although Forbes states that they exist but are "scarcely to be traced."

In 1857 McCrady described a medusa under the name *Dipurena strangulata*, and in this the 4 radial-canals are simple, but the manubrium is tubular and encircled by 2 separated, ring-like gonads.

It is evident that *Slabberia* of Forbes is similar in all respects to *Dipurena*, excepting for the problematical swellings on the radial-canals. It seems best to drop *Dipurena* and retain the older name *Slabberia*. Swellings similar to those on the radial-canals of *S. halterata* are seen on the radial-canals of other Anthomedusæ, such as *Lymnorea alexandri* and *Dysmorphosa dubia*. In *L. alexandri* the swellings are glandular and they are probably of similar function in the *Slabberia* of Forbes. Hartlaub (1907), however, states that these swellings are gonads which develop only in old medusæ. He does not state, however, that he sectioned the medusa, and the matter appears to me to be still in doubt.

### GENERIC CHARACTERS.

Codonidæ in which the manubrium is tubular and is encircled by two or more separated collar-like gonads. In other respects the medusa resembles *Sarsia*. The 4 radial-canals are simple and without gonads. The hydroid is *Syncoryne*.

In all known species of *Slabberia* each of the 4 tentacles terminates in one or more knob-like clusters of nematocysts.

Haeckel, 1879, p. 26, instituted the genus *Bathycodon* for a medusa resembling *Dipurena*, but with short, blindly-ending diverticula upon its radial-canals. We define *Slabberia* as equivalent to *Dipurena*+*Bathycodon* as defined in Haeckel's System.

Haeckel suppresses the generic name *Slabberia* on the ground that it was incorrectly defined by Forbes, but if we are to retain only the correctly defined genera we must at once drop nearly all of those defined previous to 1850, and even the majority of modern generic names must vanish! As knowledge increases it appears to me far less confusing to amend and retain old names rather than to drop them and substitute unfamiliar designations for familiar objects.

Hartlaub, 1907, would distinguish *Purena*, with nettle-warts (not rings) upon the tentacles, whereas *Slabberia* he would confine to include medusæ having tentacles ringed with nematocysts. The distinction between broken rings ("warts") and complete rings appears to me to be too slight to be of generic value, but is an important specific distinction.

### Slabberia halterata Forbes.

*Slabberia halterata*, Forbes, 1846, Annals. and Mag. Nat. Hist., vol. 18, p. 286; 1848, British Naked-eyed Medusæ, p. 53, plate 6, fig. 1.—Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 341.
*Dipurena halterata*, Haeckel, 1879, Syst. der Medusen, p. 24.
*Dipurena halterata*, Browne, 1896, Proc. Zool. Soc. London, p. 473; 1897, *Ibid.*, p. 816; 1898, plate 49, figs. 2-2*b*.—Bedot, 1905, Revue Suisse de Zool., tome 13, p. 133 (citation of literature 1846–49).
*Slabberia halterata*, Hartlaub, 1907, Nordisches Plankton, Nr. 12, p. 64, figs. 61, 62.

Bell ellipsoidal, 8 mm. high, 6 mm. wide, with thick walls. Bell cavity about three-fourths as deep as the height of the bell. 4 slender tentacles with well-developed basal bulbs, each with an abaxial, ectodermal ocellus. Each tentacle terminates in a large, elongate, swollen tip with one or two complete rings of nematocysts above it. 4 radial-canals straight and narrow, and each exhibits 1 or 2 small (glandular?) swellings (gonads?) at about one-third the distance between the inner apex of the bell-cavity and the margin. Hartlaub, 1907, believes these swellings to be true gonads which become mature only in old medusæ.

The stomach-cavity extends upward a short distance above the base of the manubrium into the gelatinous substance of the apex of the bell.

The manubrium is 4 to 7 times as long as the radius of the bell. It is slender and tubular and there is a small, spindle-shaped stomach near its distal end. The mouth is at the end of a short, conical neck and is a simple, round opening.

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2 or 3 ring-like gonads girdle the manubrium. The two upper gonads are short, the uppermost one being near the middle of the manubrium, and the next lower separated from it by a short interval. The lowermost (distal) gonad is about twice as long as either of the others, and it is adjacent to and above the stomach.

The entoderm of the basal bulbs and terminal clubs of the tentacles is reddish-brown and of the manubrium yellowish-brown. The ocelli are black.

This medusa has been taken at infrequent intervals off the southern coasts of England and Ireland. The best modern descriptions are given by Browne, 1898, and by Hartlaub, 1907.

It is distinguished by the 4 small swellings on the 4 radial-canals. According to Browne these are probably glandular, but Hartlaub regards them as gonads which develop later than the gonads upon the manubrium. Hartlaub, apparently, has not sectioned the medusa, while Browne bases his conclusions upon a study of sections.

### Slabberia strangulata Haeckel.

Plate 7, figs. 1, 2, and 3.

*Dipurena strangulata*, McCrady, 1857, Gymn. Charleston Harbor, p. 33, plate 9, figs. 1, 2.
*Dipurena cervicata*, McCrady, 1857, Gymn. Charleston Harbor, p. 34.
*Dipurena conica*, A. Agassiz in L. Agassiz's, 1862, Cont. Nat. Hist. U. S., vol. 4, p. 341.
*Dipurena cervicata*, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 341.
*Dipurena strangulata*, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 341.
*Dipurena conica*, Agassiz, A., 1865, North Amer. Acal., p. 181, figs. 301, 305.
*Dipurena strangulata=Slabberia strangulata*, Haeckel, 1879, Syst. der Medusen, p. 23.
*Dipurena conica*, Haeckel, 1879, Syst. der Medusen, p. 24.
*Dipurena strangulata*, Fewkes, 1881, Bull. Mus. Comp. Zool., vol. 8, p. 155, plate 4, fig. 5.—Brooks, 1882, Studies Johns Hopkins Univ. Biol. Lab., vol. 2, p. 136.
*Dipurena conica*, Verrill, 1873, Report Commiss. Fish and Fisheries for 1871–72, p. 735.
*Dipurella clavata* (immature), Hargitt, 1904, Bulletin of the Bureau of Fisheries, vol. 24, p. 31, plate 1, fig. 3.
*Dipurena conica*, Nutting, 1901, Bull. U. S. Fish Commission for 1899, vol. 19, p. 373.—Hargitt, 1901, American Naturalist, vol. 35, p. 578, fig. 34.
*Purena strangulata*, Hartlaub, 1907, Nordisches Plankton, Nr. 12, p. 55, fign. 51–53.

In 1857 McCrady described those which he believed to be two distinct species of *Dipurena*, *D. strangulata* and *D. cervicata*, from Charleston Harbor, South Carolina. In 1862–65, A. Agassiz described that which he believed to be another species, from Buzzards' Bay, under the name of *D. conica*. A careful study of *Dipurena* in Charleston Harbor, in September, 1897, when the medusæ were exceedingly abundant, has convinced me that all of these forms are one and the same species. McCrady found only two individuals of *D. strangulata* and one of *D. cervicata*, and thus A. Agassiz was misled into the assumption that the northern form was a distinct species. The shape of the bell is, however, very inconstant, and the length of the manubrium in the Charleston medusæ is subject to a wide range of variability.

*Adult medusa* (plate 7, fig. 1).—The bell is quite variable in shape, for in some individuals it is hemispherical, while in others it is ellipsoidal and higher than a hemisphere. All gradations between these two extremes are observed. In a large individual in which the bell was hemispherical it was 4 mm. in diameter; while another having an ellipsoidal bell was 4 mm. in height and 3 mm. in width. There are 4 stiff tentacles, one at the base of each radial-canal. Each tentacle terminates in a single, knob-like swelling which is covered with nematocysts. The entodermal core of this swelling is hollow, and its lumen is placed in communication with the general gastrovascular system of the medusa by means of a narrow thread-like canal which extends through the entire length of the tentacle. The basal bulb of each tentacle is large and there is a single, ectodermal ocellus mounted upon a short pedicel, upon the outer side of the bulb. The tentacles are all of equal length, and each one is about three-fourths as long as the bell-diameter. The velum is wide. There are 4 straight, simple radial-canals and a narrow, circular tube. The gastric cavity projects upward a short distance into the gelatinous substance of the bell at the point of intersection of the 4 radial-canals. The manubrium is always long and increases in length with advancing age. In mature medusæ it projects far beyond the velar opening and varies in length from 5 to 10 mm. It is tubular and highly contractile, and the mouth is a simple, round opening. Four distinct regions may be distinguished upon the manubrium of the mature medusa. First, a long, narrow, tubular region, extending from the inner apex of the bell-cavity to about the level of the velar opening, then a short, fusiform, swollen region, then a short, narrow, tubular region similar in size to the

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PLATE 7.

Fig. 1. *Slabberia strangulata*, mature male. Charleston Harbor, South Carolina, September 8, 1897.

Fig. 2. *Slabberia strangulata*, half-grown medusa. Charleston Harbor, South Carolina, September 11, 1897.

Fig. 3. *Slabberia strangulata*, young medusa. Charleston Harbor, South Carolina, September 7, 1897.

Fig. 4. *Slabberia strangulata* var. *fragilis*. Tortugas, Florida.

Fig. 5. *Zanclea gemmosa*, young medusa. Agassiz Laboratory, Newport, Rhode Island, September 17, 1892.

Drawn from life, by the author.

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proximal part of the manubrium, and finally at the distal end a long, club-shaped, cylindrical region, at the extremity of which the mouth is situated. The 2 genital organs are found within the 2 swollen regions of the manubrium. The color of these medusæ is quite variable, the entoderm of the manubrium and tentacles being either yellow, or yellow and red, or red, or green and red. In the young medusæ the entoderm of the manubrium is usually yellow, and of the tentacles yellow dotted with red granulations; while in the mature medusa the color of the entoderm is usually green or yellowish-green.

*Young medusa* (plate 7, fig. 3).—In the youngest medusa observed, the bell is cylindrical with vertical sides and a slight apical projection. The gelatinous substance is thin.. There are 2 diametrically opposed tentacles each of which terminates in a single, large, nematocyst-covered knob. The other 2 tentacles are as yet undeveloped and are represented by mere basal bulbs. There are 4 ocelli, one upon each basal bulb. The manubrium is a simple, short, conical tube and the mouth is a simple, round opening.

When the medusa is 1 mm. in height, a constriction appears near the proximal end of the manubrium, which thus becomes divided into an upper and lower swollen region. As development proceeds this constriction becomes more marked and finally the manubrium assumes the adult shape; the upper and lower swellings of the young proboscis corresponding to the two swollen regions of the manubrium of the adult medusa. Hargitt, 1904, describes the young medusa under the name of "*Dipurella clavata*."

This medusa is exceedingly abundant in August and September in Charleston Harbor, South Carolina. It has been found by Brooks at Beaufort, North Carolina; and by A. Agassiz and Verrill in Buzzards' Bay, Massachusetts. It has not been taken north of Cape Cod, Massachusetts, and has not been observed at the Tortugas, Florida.

### Slabberia strangulata var. fragilis.

Plate 7, fig. 4.

*Dipurena fragilis*, MAYER, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 29, plate 17, fig. 41.
(?) *Dipurena fragilis*, BIGELOW, 1904, Bull. Mus. Comp. Zool. at Harvard College, vol. 39, p. 251.

Bell 4 mm. high and half-egg-shaped, with moderately thick walls, becoming thinner near the margin. There are 4 long, slender tentacles, each about as long as the bell-height. These terminate each in a single knob armed with nematocysts. The tentacle-bulbs upon the bell-margin are not large, but each one bears a single, black ocellus in the ectoderm of its outer side. Velum wide. There are 4 straight, narrow radial-canals and a slender, circular vessel. Manubrium about twice as long as bell is high. It is slender and tubular, with two separate, swollen regions containing the gonads. The entoderm of the manubrium and of the basal bulbs of the tentacles is dull yellow, while the entoderm of the terminal knobs of the tentacle is a faint orange.

This variety is found at Tortugas, Florida, in June. Bigelow, 1904, found a colorless *Dipurena* at Suvadiva Atoll, Maldive Islands, Indian Ocean, which he believes is probably identical with *Dipurena fragilis*.

*S. fragilis* may be distinguished from other American Dipurenæ by its long, *very slender* tentacles, and the dull-yellow color of its entoderm.

### Slabberia catenata Forbes and Goodsir.

Plate 8, figs. 8 and 9.

*Slabberia catenata*, FORBES and GOODSIR, 1853, Trans. Roy. Soc. Edinburgh, vol. 20, p. 311, plate 10, figs. 3*a*–3*e*.
*Dipurena dolichogaster*, HAECKEL, 1864, Jena. Zeitschrift für Naturw., Bd. 1, p. 337; 1879, Syst. der Medusen, p. 25, taf. 2, figs. 1–7.
*Dipurena catenata*, HAECKEL, 1880, Syst. der Medusen, p. 655.
*Dipurena fertilis*, METSCHNIKOFF, E. and L., 1870, Verhandl. Gesell. Freunde Nat. Moskau, tome 8, p. 343, taf. 3, figs. 1–5.
*Sarsia dolichogaster*, SPAGNOLINI, 1876, Catalogo Acalefi Mediterraneo, p. 18, tav. 2, fig. 3 (from Naples, Italy).
*Dipurena dolichogaster*, CHUN, 1895, Bibliotheca Zoologica, Heft 19, p. 6, taf. 1, figs. 1–4.
*Dipurena catenata*, MONTICELLI, 1897, Atti Accad. Sci. Torino, vol. 32, p. 888, 1 fig. (abnormal specimen from the Gulf of Cagliari, with a manubrium which gives off 2 side branches, each with mouth and gonad).
(?) *Sarsia clavata*, KEFERSTEIN, 1862, Zeitschrift für wissen. Zool., Bd. 12, p. 27, taf. 2, figs. 1, 2.
(?) *Sarsia*, sp., ALLMAN, 1871, Monog. Tubul. Hydroids, p. 83, fig. 37.
(?) *Sarsia clavata*, HAECKEL, 1879, Syst. der Medusen, p. 19.
(?) *Sarsia clavata* (*Syncoryne clavata*), GRAEFFE, 1884, Arbeit. Zool. Inst. Wien, Bd. 5, p. 351 (first description of the hydroid).
*Dipurena picta*, MAYER, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 29, plate 18, figs. 45, 46.
(? *Sarsia clavata*)+*Slabberia catenata*, HARTLAUB, 1907, Nordisches Plankton, Nr. 12, pp. 51, 63, figs. 46, 59.

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### DESCRIPTION OF AMERICAN SPECIMENS.

Bell high with straight, vertical sides and flatly-rounded top, about 3 mm. high and 1.5 mm. wide. Bell-walls very thick and of a rigid, gelatinous consistency. Bell-cavity about two-thirds as deep as the total height of the bell itself. There are 4 radially situated, slender tentacles, all of the same length and not quite as long as the bell-height. Each of these tentacles terminates in 3 to 5 bulb-shaped, ring-like swellings containing nematocysts. The basal bulbs of the tentacles are large and swollen, and each of them bears a dark-purple, ectodermal ocellus upon its outer side. There are 4 straight, narrow radial-canals and a simple, slender, circular vessel. The velum is quite narrow. The manubrium is a slender tube about 5 mm. long; and it exhibits two separate, annular, swollen regions marking the places where the gonads are situated. The mouth is a simple, round opening. The entoderm of the manubrium and of the tentacle-bulbs is of a beautiful custard-yellow, while the entoderm of the terminal series of knobs on the tentacles is of a rich port-wine color.

Several specimens were found in a surface-tow at Tortugas, Florida, early in August, 1898, and in July, 1906.

### DESCRIPTION OF EUROPEAN SPECIMENS.

For details of the general characters of the European medusa, see tabular description of the medusæ of *Slabberia*.

Forbes and Goodsir, 1853, describe this medusa from the western coast of Scotland, at Tobermory and Loch Laigh.

Keferstein, 1862, and Allman, 1871–72, describe that which I doubtfully believe to be this medusa from the coasts of France and England. It is the immature condition before the appearance of gonads, while medusa-buds are still being produced upon its manubrium, and before the development of nettle-rings upon its tentacles. Chun, 1895, has made a most careful study of this budding process in specimens from the Mediterranean.

Haeckel, 1879, describes this medusa from the Mediterranean, but did not observe it in the stage wherein medusa-buds are being produced. An identical medusa is found at Tortugas, Florida.

Chun, 1895, has made a careful study of the budding process. When the medusa is young the manubrium is slender and cylindrical and without gonads. Medusa-buds develop at this stage. These budding medusæ develop in a helical line at regular intervals down the sides of the manubrium. The oldest of the primary series of medusa-buds is nearest the base and the youngest nearest the mouth of the manubrium.

These primary medusa-buds are attached by narrow pedicels to the sides of the manubrium, and a second series of medusa-buds develop upon the sides of these pedicels, before the primary medusæ are set free. After the primary medusæ are set free the secondary medusa-buds complete their development. Thus the manubrium may present various appearances; the oldest medusa-buds *at any one time* may be above, or below, or anywhere upon the manubrium. Before they are set free the budding medusæ begin to develop a secondary generation of medusa-buds upon their manubria.

The hydroid of this medusa is described by Graeffe from Trieste, Adriatic Sea. Graeffe succeeded in rearing the hydroid from the eggs of the medusa. It is a *Syncoryne*. The polypites are cup-shaped, only 2 to 3 mm. long, and have 4 circlets of 4 tentacles each. The tentacles are short and stiff, and each one ends in a nematocyst-knob. The short stems of the hydroid are invested by an irregularly ringed perisarc. The hydrorhiza forms a mass of profusely branched anastomosing stolons. The medusa-buds arise from the sides of the polypites between the 2 lowest circlets of tentacles. When set free the medusa has a short manubrium and 4 tentacles. The tentacles have terminal nematocyst-knobs and a nettling ring.

The eggs are laid in May and June and the mature hydroid is found in October at Trieste.

Chun is of the opinion that *Sarsia clavata* is identical with "*D. dolichogaster*"; but Hartlaub regards *S. clavata* as being distinct and a true *Sarsia*. The absence of a series of rings upon the tentacles of *S. clavata* inclines me to agree with Hartlaub that it is a *Sarsia* and not to be confused with *Slabberia catenata*. Further studies appear to be required before any final opinion can be formed upon this case.

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### Slabberia ophiogaster.

*Sarsia strangulata*, ALLMAN, 1871–72, Monograph Tubularian Hydroids, p. 46, fig. 17.
*Dipurena ophiogaster*=*Tetrapurena ophiogaster*, HAECKEL, 1879, Syst. der Medusen. p. 25.
*Dipurena ophiogaster* (?), BROWNE, 1905, Pearl Oyster Fisheries, Gulf of Manaar, Roy. Soc. London, Suppl. Report 27, p. 133, plate 2, figs. 1, 2 (from Galle Bay, Ceylon).
*Purena strangulata*, HARTLAUB, 1907, Nordisches Plankton, Nr. 12, p. 55, figs. 51–53.

This medusa is found off the southern coasts of England and Ireland, and an apparently identical species is described by Browne from Ceylon. Dr. Lobianco kindly permitted me to study a specimen, which I consider to be of this medusa, from Naples, Italy.

For details, see tabular description of the medusæ of *Slabberia*.

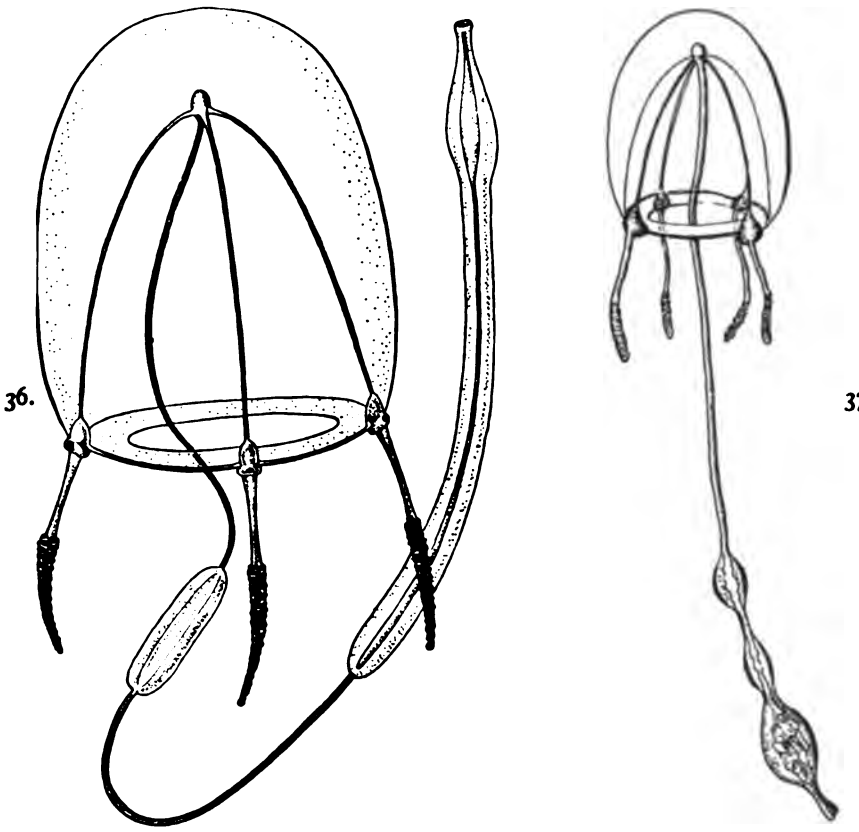

FIG. 36.—*Slabberia ophiogaster*. Drawn by the author, from a specimen collected by Dr. Lobianco in the Bay of Naples.
FIG. 37.—"*Purena strangulata*" (*S. ophiogaster*), after Hartlaub, in Nordisches Plankton.

In the specimen in Dr. Lobianco's collection from Naples, the bell is 5 mm. high, 4 mm. wide; oval, with thick walls. The manubrium is 13.5 mm. long and has 2 gonads, one in the middle of its length and one adjacent to the stomach. The 4 tentacles are each 2.5 mm. long, and their outer halves taper to a point and are covered with broken, partial rings of nettle-cells. The proximal halves of the tentacles are smooth and cylindrical. The tentacle-bulbs are swollen below the bell-margin and have ocelli.

### Slabberia pyramis.

*Bathycodon pyramis*, HAECKEL, 1879, Syst. der Medusen, p. 26.

This Mediterranean medusa is distinguished from other species of *Slabberia* by the terminal "suction cups" upon its tentacles and by the numerous "glandular" organs which line the sides of the radial-canals. For details see the tabular description of medusæ of *Slabberia*.

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## Genus MARGELOPSIS Hartlaub.

*Nemopsis* (hydroid only), McCrady, 1857, Gymn. Charleston Harbor, Proc. Elliott Society of Charleston, vol. 1, p. 163, plate 10, figs. 4–7.

*Margelopsis*, Hartlaub, 1897, Hydromedusen Helgolands, Wissen. Meeresuntersuch., Biolog. Anstalt auf Helgoland, Neue Folge, Bd. 2, p. 482; *Ibid.*, 1904, Bd. 5, p. 99; 1899, Nachrich. k. Gesell. der Wissenschaften Göttingen, math.-phys. Klasse, p. 219; Zool. Centralbl., Bd. 10, p. 28; 1907, Nordisches Plankton, Nr. 12, p. 88.—Browne, 1903, Bergens Museums Aarbog, No. 4, p. 10.—Müller, 1908, Zeit. für wissen. Zool., Bd. 89, pp. 43, 73.

### GENERIC CHARACTERS.

Anthomedusæ with simple, round mouth-opening without oral tentacles, or cruciform lips. With 4 radially placed clusters of marginal tentacles and 4 radial-canals. The ring-like gonad encircles the stomach. The hydroid is the pelagic *Margelopsis*.

The tentacles of the hydroid are confined to definite whorls. In 1857, McCrady described a free-floating hydroid from Charleston Harbor which has two whorls of tentacles, and between them a number of medusa-buds arise from the sides of the hydranth. When set free the medusæ bore some resemblance to *Nemopsis*, and McCrady believed them to be the young of *Nemopsis gibbesii*=*Nemopsis bachei* L. Agassiz. We now know this to have been a mistake, for Hartlaub, 1899, discovered that actinula larvæ develop upon the sides of the manubrium in *Margelopsis haeckelii*. Then these actinulæ are set free with two whorls of tentacles, and medusa-buds develop from the sides of the hydranth between the whorls, and are set free, as in McCrady's hydroid, which is, indeed, a species of *Margelopsis*.

In 1904 Hartlaub found another free-floating hydranth (*Margelopsis stylostoma*) which is apparently detached from *Tiarella singularis* F. E. Schulze. It is apparent that the Siphonophoræ may have been derived from hydroid forms having a similar life-history.

The medusæ of this most interesting genus appear to form a connecting link between the Codonidæ and Margelidæ of Haeckel. They resemble the Codonidæ in their simple mouth-opening without oral tentacles or prominent lips, and in the single ring-like gonad surrounding the manubrium. On the other hand, they resemble the Margelidæ in having the marginal tentacles grouped into 4 radially situated clusters. There are, however, no tentacular ocelli such as are seen in the Margelidæ.

The Atlantic species are all very closely related and may prove to be but one. The chief distinctions are the number of tentacles upon each tentacle-bulb. For example: *M. hartlaubii* Browne has 2; *M. haeckelii* Hartlaub has 3 to 4; *M. gibbesi* Hartlaub has 5 to 6.

The medusa of *M. stylostoma*, and the hydroid of *M. hartlaubii* are unknown, and it is possible that these two may be phases in the life-history of one and the same animal.

The so-called "*Perigonimus sulphureus*" Chun, 1889 (Sitzungsber. Akad. Wissen. Berlin, Jahrg. 1889, p. 524), and Steche, 1906 (Zool. Anzeiger, Bd. 31, p. 30, 2 figs.), is probably not a *Perigonimus*, but may give off pelagic hydranths. Chun found this hydroid growing upon a living shell of *Hyalæa* in the Canary Islands. One portion of the net-like hydrorhiza gives rise to isolated polypites, and another portion to the medusa-buds. The hydranths arise directly from the hydrorhiza and are unbranched. They are barrel-shaped, large, and with an oral circlet of 6 to 9 short, blunt tentacles. One of the hydranths was sharply constricted by a ring-furrow in the middle of its length as if the oral end were about to be set free and to become pelagic (Steche). The medusa-buds also arise singly from the hydrorhiza, each of the medusa-buds being placed upon a short, unbranched peduncle. When set free the medusæ have 4 short tentacles with swollen basal bulbs, and the manubrium does not project beyond the velar opening. The entoderm of the hydroid and medusa is sulphur-yellow. The periderm of the hydroid is smooth and has none of the foreign bodies attached to it such as are seen in *Perigonimus*. According to Steche the colony feeds upon the eggs which are set free by the *Hyalæa* on which it grows.

### Margelopsis haeckelii Hartlaub.

*Margelopsis hæckelii*, Hartlaub, 1897, Wissen. Meeresuntersuch. Kommis., Meere Kiel, Helgoland, Neue Folge, Bd. 2, p. 482, taf. 16*b*, fign. 12–18; 1899, Nachricht. kgl. Gesell. Wissen. math.-phys. Klasse, Göttingen, Jahre 1899, p. 219, 3 fign.; 1907, Nordisches Plankton, Nr. 12, pp. 89, 91, fign. 84–86 (best published description of hydroid and medusa).—Müller, 1908, Zeit. für wissen. Zool., Bd. 89, pp. 43, 73, taf. 5, fign. 18, 19.

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## Plate 8.

Fig. 1. *Zancleopsis dichotoma*. Tortugas, Florida, May 28, 1899.

Figs. 2 and 3. *Gemmaria costata* (?), hydroid and medusa. Tortugas, Florida, June, 1899. This is probably the hydroid of *Zanclea costata*.

Figs. 4 and 5. *Zanclea gemmosa*, young medusa. Figure 5 shows details of nematocyst-capsules of the tentacles. Agassiz Laboratory, Newport, Rhode Island, June 19, 1893.

Fig. 6. *Zanclea costata*. Tortugas, Florida, May 15, 1906.

Fig. 7. *Zanclea costata*. Details of nematocyst-knobs of tentacles.

Figs. 8 and 9. *Slabberia catenata*. Tortugas, Florida, August, 1898. Figure 9 shows end of one of the tentacles of the medusa shown in figure 8.

Drawn from life, by the author.

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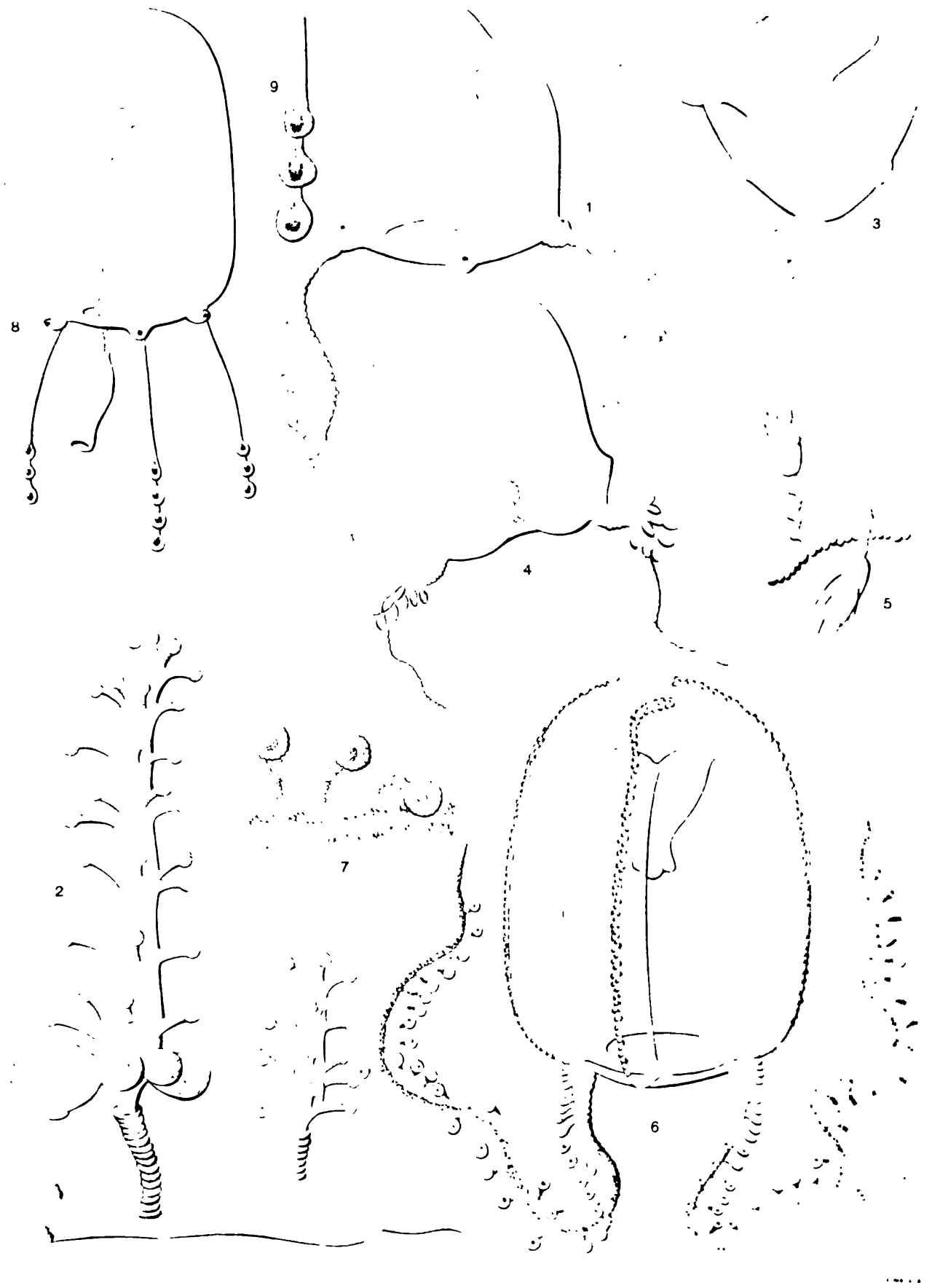


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*Medusa.*—Bell pyriform with a flat apex 1.3 times as high as wide. 2 mm. high. Gelatinous walls quite thick. 3 or 4 tentacles upon each of the 4 marginal tentacle-bulbs. These tentacles are ringed with nematocysts. No ocelli. 4 narrow, straight radial-canals and a wide axial-canal above the stomach. Manubrium wide, spindle-shaped, two-thirds as long as the depth of the bell-cavity. The upper third of the manubrium has no gonad, but the lower part is incased in a tubular genital organ which bears planulæ. Tentacle-bulbs brown. Manubrium with dark-brown pigment granules. Found at Helgoland, German Ocean, in July and early in August.

*Hydroid.*—The planulæ which develop upon the manubrium of the medusa grow into actinula larvæ before being set free. The oral pole of the actinula is blunt and is adjacent to the wall of the stomach of the medusa, while the aboral pole projects outward from the stomach-wall into the bell-cavity. This aboral pole is conical and terminates in a sucker-shaped depression. There is a row of 5 to 7 short, somewhat club-shaped tentacles around the oral pole and two closely-set rows of alternately arranged tentacles near the aboral pole. Both aboral rows have together about 12 tentacles, and these are somewhat longer than the 5 or 7 oral tentacles. The middle part of the body of the actinula is devoid of tentacles.

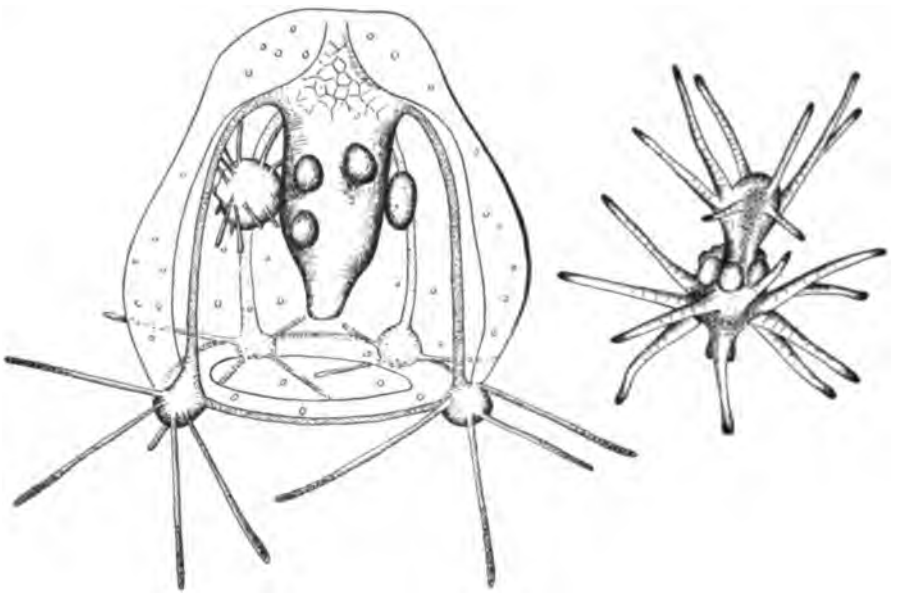

FIG. 38.—Hydroid and medusa of *Margelopsis haeckelii*, after Hartlaub, in Nordisches Plankton. Medusa is about to set free an actinula larva.

Medusa-buds develop after the actinula has been set free and has become about 1 mm. long. These medusa-buds develop in clusters from the sides of the body of the actinula close to the bases of the lower row of aboral tentacles with which they alternate in position. The medusa-buds develop 2 or 3 tentacles in each of their 4 marginal clusters while still attached to the actinula. Hartlaub found large numbers of these interesting hydroids floating in the water at Helgoland, late in August.

Müller, 1908, has studied the origin and structure of the ova in the medusa. In common with *Hybocodon*, the eggs are large, amœboid, and few in number when full grown, for the successful eggs devour the weaker ones in the ovary. The ooplasma is composed of wide irregular fibers, forming a somewhat narrow-meshed network. The exoplasma is distinct from the endoplasma and is wider in its meshes.

### Margelopsis stylostoma Hartlaub.

*Margelopsis stylostoma*, HARTLAUB, 1903, Zoolog. Centralblatt, Bd. 10, p. 28, fig. 2, fig. 4 (?); 1904, Wissen. Meeresuntersuch. Kommis. Deutsch. Meere, Abth. Helgoland, Neue Folge, Bd. 5, p. 99, fig. 1, fig. 2 (?); 1907, Nordisches Plankton, Nr. 12, p. 91, fig. 87 (88?).

This is a small spindle-shaped, free-floating hydranth, with a sucker-like expansion at its aboral pole, and with three verticils of tentacles, i. e., 4 short-knobbed oral tentacles, a



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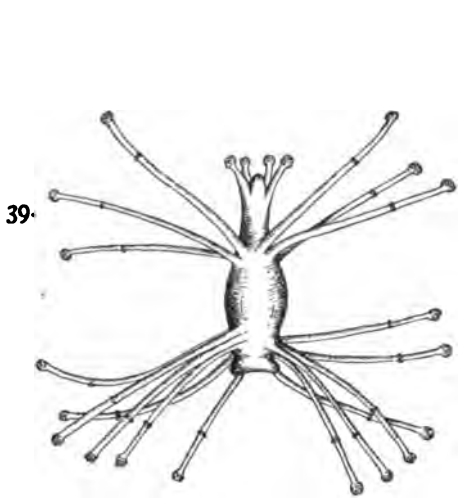
middle zone of about 10 to 12 long-knobbed tentacles, and a basal (aboral) zone of about 10 to 12 long-knobbed tentacles. Medusa-buds (?) This form closely resembles *Tiarella singularis* F. E. Schulze, 1876, a small, isolated, attached hydroid found at Trieste. *T. singularis* produces medusæ at the base of the polypite below the third zone of tentacles.

*Margelopsis stylostoma* was found at Roscoff, northwest coast of France, in June.



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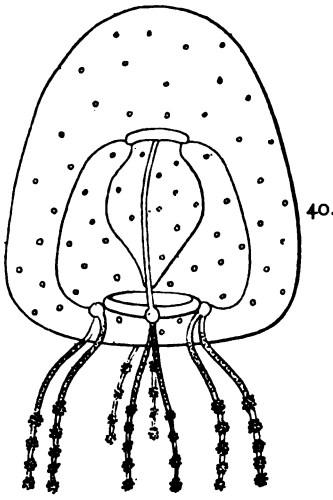

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FIG. 39.—Hydroid of *Margelopsis stylostoma*, after Hartlaub, in Nordisches Plankton.
FIG. 40.—*Margelopsis hartlaubii*, after Browne, in Bergens Museums Aarbog, 1903.

**Margelopsis hartlaubii Browne.**

*Margelopsis hartlaubii*, BROWNE, 1903, Bergens Museums Aarbog, No. 4, p. 10, plate 1, fig. 2, plate 3, fig. 3.—HARTLAUB, 1907, Nordisches Plankton, Nr. 12, p. 92, fig. 89.

Bell 2 mm. wide, 2 mm. high. Egg-shaped, with thick walls. 8 marginal tentacles, 2 upon each radially placed marginal bulb. These tentacles are ringed with nematocysts, and are somewhat shorter than the bell-diameter. No ocelli. 4 narrow radial-canals. Stomach large, conical, with a broad, flat, quadrangular base, without an axial, apical canal. Mouth a simple, round opening. Gonad encircling the stomach. Color (in formalin): Gonads, stomach, and tentacle-bulbs yellowish-brown. Three specimens; coast of Norway, Osterfjord and Herlfjord, from depths of 0 to 200 fathoms.

**Margelopsis gibbesi Hartlaub.**

Plate 9, figs. 4–7.

*Nemopsis gibbesii*, MCCRADY, 1857, Gymn. Charleston Harbor, p. 163, plate 10, figs. 4–7.—FRECH, 1898, *Lethæa palæozoica*, Theil 1, Bd. 1, Lfg. 3, p. 565, Stuttgart (compared with the *Graptolites* as a floating Tubularian).
*Margelopsis gibbesi*, HARTLAUB, 1903, Zoolog. Centralbl., Bd. 10, p. 28; 1899, Nachricht. kgl. Gesell. Wissen. math.-phys. Klasse, Göttingen, Jahre 1899, p. 223, fig. 4.

Bell somewhat higher than a hemisphere, 2.5 mm. high, and walls quite thin and uniform. There are 4 radially situated clusters of marginal tentacles. Each cluster contains 5 or 6 tentacles which arise from a large common basal bulb. Tentacles taper regularly from base to tip, but the tip terminates in a knob of nematocysts. There are about 15 rings of nematocysts upon the shaft of each tentacle and the entodermal axis of the tentacle is composed of chordate cells resembling those of *Obelia*. There are 4 straight, narrow radial-canals. Velum well developed. Manubrium wide and flask-shaped, and mouth a simple, round opening without prominent lips, and without oral tentacles. In the female the ova project prominently from the surface of the manubrium. The gonad surrounds the stomach on all sides. The bell of this medusa is highly contractile, often drawing together so as to cause the mouth to project beyond the velar opening. When the bell is relaxed, however, the manubrium extends but little more than half-way from the inner apex of the bell-cavity to the velar opening.

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## Plate 9.

Fig. 1. *Cladonema perkinsii*. Nassau Harbor, Bahamas.

Fig. 2. *Cladonema mayeri*. Moat of Fort Jefferson, Tortugas, Florida, July, 1905.

Fig. 3. View looking down upon the aboral end of the stomach of *Cladonema mayeri*, showing the arrangement of the radial-canals.

Fig. 4. *Margelopsis gibbesii*, male. Beaufort, South Carolina, December 24, 1904.

Fig. 5. *Margelopsis gibbesii*, male. Oregon Inlet, Pamlico Sound, North Carolina, November 12, 1904.

Fig. 6. *Margelopsis gibbesii*, female. Cape Fear, North Carolina, December 1, 1904.

Fig. 7. Tentacle of *Margelopsis gibbesii*.

Figs. 8 and 9. *Stomotoca dinema*, young females. Agassiz Laboratory, Newport, Rhode Island, July, 1892.

Fig. 10. *Stomotoca dinema*, young male. Agassiz Laboratory, Newport, Rhode Island, Septemper 15, 1896.

Fig. 1, copied from a drawing by Prof. Henry F. Perkins.
Figs. 2 to 10, from life, by the author.

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The entoderm of the four large tentacle-bulbs is dull-yellow. There are no ocelli. The entoderm of the manubrium was dull-yellow in two medusæ, and dull-green in another. The difference is not a sexual one, however, for one of the males was yellow while the other was dull-green. The two yellow-colored medusæ were found, one in Oregon Inlet, Pamlico Sound, North Carolina; and the other at Southport, Cape Fear, North Carolina, in November. The green-colored male (plate 9, fig. 4) was found in Beaufort River, at Beaufort, South Carolina, on December 24, 1903, 12 miles from the ocean, in brackish water.

McCrady, 1857, presents a good figure of that which is probably the free-floating hydroid of this species. The hydroid is pear-shaped with a hollow cup-like projection from its broad aboral end. There are 2 whorls of tentacles, a circlet of about 8 tentacles around the broadest zone near the aboral end and a circlet of about 6 tentacles near the mouth. A number of medusa-buds develop from the sides of the hydranth in the middle region between the 2 circlets of tentacles. When set free the medusæ have 4 short tentacles in each radial cluster. A single specimen was found by McCrady in Charleston Harbor. The cup-shaped projection from the aboral end of the hydranth is a feature which recalls the pneumatophore of the Siphonophoræ.

### Genus PELAGOHYDRA Dendy.

*Pelagohydra*, DENDY, 1903, Quart. Journ. Microscop. Sci., vol. 46, p. 1.—HARTLAUB, 1903, Zool. Centralblatt, p. 27.

The type species is *Pelagohydra mirabilis*, Dendy, from New Zealand.

#### GENERIC CHARACTERS.

Medusa similar to *Margelopsis*. Hydroid pelagic and closely resembles that of *Margelopsis*, but tentacles arise irregularly from the sides of the hydranth, and are not arranged in definite circlets as in *Margelopsis*.

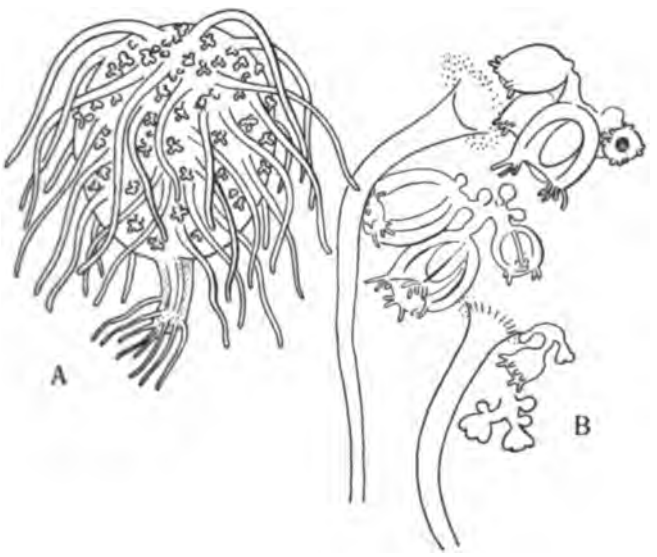


FIG. 40a.—*Pelagohydra mirabilis*, after Dendy, in Quarterly Journal Microscop. Science.
*a*, entire hydroid, twice natural size.
*b*, enlarged view, showing medusa-buds developing among tentacles.

#### Pelagohydra mirabilis Dendy.

*Pelagohydra mirabilis*, DENDY, 1903, Quart. Journ. Microscop. Science, vol. 46, p. 1, plate 12.—HARTLAUB, 1903, Zool. Centralbl., p. 27, fig. 3.

Hydroid pelagic, with a translucent globular body 25 mm. wide, constituting a float and a proboscis at the end of which the mouth is situated. The float bears many long, irregularly arranged tentacles. The proboscis is elongate, pink in color, and of the shape of a truncated cone. It has several irregular whorls of oral tentacles, the shortest being nearest the mouth. Medusæ are borne upon branching stolons which arise from the sides of the float between the tentacles. When about to be set free the medusa is about 1 mm. wide, with 4 radial groups of marginal tentacles, each group arising from a large, pink, basal bulb, and consisting of 5 tentacles, 2 large, 2 small, and 1 smallest median tentacle. 4 radial-canals. Manubrium pyriform and without oral tentacles. New Zealand.

### Family CLADONEMIDÆ.

*Cladonemidæ*, GEGENBAUR, 1856, Zeit. für wissen. Zool., Bd. 8, p. 220.—HAECKEL, 1879, Syst. der Medusen, p. 98.—HARTLAUB, 1887, Zool. Anzeiger, Bd. 10, p. 651; 1907, Nordisches Plankton, Nr. 12, pp. 5, 110.—GUNTHER, 1903, Mittheil Zool. Sta. Neapel, Bd. 16, pp. 56, 57.

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This family is of such interest that we devote more than the usual space to its consideration. Haeckel, 1879, classifies it as a family coordinate with the Codonidæ, but Hartlaub, 1887, showed that the genus *Cladonema* had an encircling gonad as in the Codonidæ. The medusæ are, however, highly specialized, both in respect to their anatomy and their mode of life, and they are undoubtedly derived from some more simply-organized medusæ among the Codonidæ. The hydroid of *Cladonema* is a *Stauridia*, and is closely related to *Syncoryne*, the hydroid of *Sarsia*.

### CHARACTERS OF THE FAMILY CLADONEMIDÆ.

Anthomedusæ with feathered or branched marginal tentacles, and with four or more simple or branched radial-canals. The gonads may be ring-like and encircle the stomach, or they may be more or less separated so as to be interradial or adradial, or developed in a specialized brood-pouch above the stomach.

Hartlaub, 1887, and Perkins, 1902, show that in the genus *Cladonema* the genital products are developed over the entire gastric portion of the manubrium and the gonads are not confined to restricted meridians, as was believed to be the case by Haeckel. Hartlaub found that in *Cladonema radiatum* of the Mediterranean the genital products begin to develop in the entoderm. This species exhibits a successive hermaphroditism, although either sperm or ova may precede. Perkins, however, in his study of *Cladonema perkinsii* of the Bahamas, found that the genital products were developed in the ectoderm of the manubrium, and he failed to find sperm or ova in the entoderm.

In *Eleutheria*, Hartlaub, 1886, 1887 (Zool. Anzeiger), showed that the genital products are developed exclusively in the ectodermal lining of a peculiar brood-pouch above the stomach, and that the medusa is hermaphroditic. The brood-pouch is derived from the ectodermal layer of the bell-cavity and is not connected with the stomach of the medusa, but communicates with the bell-cavity by means of 6 interradial-canals.

Hartlaub, 1887, divides the Cladonemidæ into two groups, one with and the other without an apical brood-sac above the stomach. As this brood-sac is highly variable in its development, some specimens of *Eleutheria* apparently failing to develop it and, moreover, as it is a character which develops during the growth of the medusa and is not found in the young animal, it would seem that Haeckel's classification of the Cladonemidæ, based as it is upon the possession of constant characters, is to be preferred. Moreover, as has been shown by Günther, 1903, we can not yet state that the brood-pouch of other genera of Cladonemidæ is similar in structure to that of *Eleutheria*.

As is well known, Haeckel, 1879 (Sitzungsber. Medicin. Naturwiss. Ges. Jena; see also Chun, 1880, Ctenophoren des Golfes von Neapel), drew an ingenious comparison between *Ctenaria* and the Ctenophoræ, and concluded that the Ctenophoræ might have been derived from some form of Anthomedusa. *Ctenaria* appears to resemble the Ctenophoræ in its 2 feathered tentacles, 4 bifurcated radial-canals, and in a peculiar sheath at the base of each tentacle. However, Hartlaub's discovery that the brood-pouch in the closely-related *Eleutheria* is of ectodermal and not entodermal origin makes it appear that the resemblances between *Ctenaria* and the Ctenophoræ are of the nature of a mere parallelism and not indicative of a genetic relationship. Haeckel compared the 8 adradial longitudinal lines of nematocysts upon the exumbrella of *Ctenaria* with the 8 rows of ciliated combs in the Ctenophoræ. An even more remarkable case of convergence is shown by Kofoid, 1905 (Bull. Mus. Comp. Zool. at Harvard College, vol. 46, p. 163, 1 plate), in the case of the Cystoflagellate, *Craspedotella*, which is bell-shaped and provided with a well-developed velum, the walls of which are contractile so that the mode of locomotion is similar to that of a medusa. There is thus an external similarity of form between this protozoan and a medusa offering an instance of convergence of a most striking character. Another remarkable instance of convergence is that of the pelagic holothurian *Pelagothuria natatrix*, which bears a close resemblance to a medusa (see Mem. Mus. Comp. Zool. at Harvard College, vol. 17, 1894). I believe also that the bell of the Narcomedusæ is not homologous with that of the Anthomedusæ and Leptomedusæ, but is a mere outgrowth from the walls of the actinula larva.

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The Cladonemidæ are close relatives of the Codonidæ, this being illustrated most clearly by their hydroids, and they may properly be regarded as highly-specialized Codonidæ, as has been maintained by Hartlaub. For purposes of classification, however, I think it will be well to permit them to remain in a family of Anthomedusæ coordinate with the Codonidæ, for there is no single character which they have consistently in common with the Codonidæ. For example, the gonad in *Cladonema* may be readily likened to that of the Codonidæ, for it encircles the stomach on all sides, but in some species of *Zanclea* the gonads show a decided tendency to segregate interradially, and in *Eleutheria* they are developed in an ectodermal brood-sac which is not connected with the manubrium.

The most constant character of the Cladonemidæ is their forked, or feathered, marginal tentacles.

The greatest difficulty in any attempt to classify the Cladonemidæ among themselves arises from our lack of understanding of the nature of the brood-sac or apical cavity in the bell of the genera *Pteronema*, *Ctenaria*, and *Dendronema*; and no classification worthy of serious consideration can be effected until we know whether this sac is a mere extension of the stomach or an ectodermal reproductive cavity similar to that studied by Hartlaub in *Eleutheria*.

FAMILY: CLADONEMIDÆ. Subfamily *Pteroneminæ:*

Manubrium without oral tentacles. With 4 to 8 simple radial-canals.

*Zanclea* GEGENBAUR, 1856. With 2 to 4 marginal tentacles at bases of 4 radial-canals. The tentacles give rise to an abaxial row of simple branches, each terminating in a cluster of nematocysts. With meridional rows of nematocysts upon the exumbrella. No ocelli. No brood-pouch above the stomach. The hydroid is *Gemmaria* McCrady, Allman.

*Zancleopsis* HARTLAUB, 1907. Similar to *Zanclea*, but with tentacular ocelli and without meridional rows of nematocysts.

*Pteronema* HAECKEL, 1879. With 4 well-developed tentacles similar in structure to those of *Zanclea*. With 4 simple radial-canals. With a brood-sac above the stomach. Hydroid unknown.

*Eleutheria* QUATREFAGES, 1842. With 4 to 6 simple radial-canals, and an equal number of bifurcated tentacles. With a brood-pouch above the stomach. This brood-pouch is not connected with stomach-cavity, but communicates with bell-cavity by means of simple interradial pores. Genital products develop exclusively in brood-pouch. Medusa is hermaphroditic. Hydroid is *Clavatella* Hincks.

*Mnestra* KROHN, 1853 (Archiv. für Naturges., Jahrg. 19, Bd. 1, p. 278). Medusa degenerate, sessile upon *Phyllirhoë* in the Mediterranean. With 4 to 0 small marginal tentacles having nettling capsules along their abaxial sides. A ring of nematocysts extends around the bell-margin, and 4 linear tracts of nettle-cells extend upward over the exumbrella, 1 from each tentacle-bulb. With 4 simple, unbranched radial-canals and ring-canal. No brood-pouch above stomach. Throat of medusa blocked by a spongy mass of entoderm. Medusa attaches itself by its mouth to throat of *Phyllirhoë*, and the larvæ of the *Mnestra* probably develop within the gastric cavity of the *Phyllirhoe*. It is elaborately described by Günther, 1903 (Mitt. Zool. Sta. Neapel, Bd 16, pp. 35–62, plates 2, 3).

FAMILY: CLADONEMIDÆ. Subfamily *Dendroneminæ:*

The mouth is surrounded by simple, or branched, oral tentacles. Some or all of the radial-canals bifurcate.

*Ctenaria* HAECKEL, 1879. With 2 marginal tentacles, each of which gives rise to a row of nematocyst-bearing filaments. With 4 bifurcated radial-canals. With simple, unbranched, oral tentacles. With an apical sac above the stomach. Hydroid unknown.

*Cladonema* DUJARDIN, 1843. With 4 to 5 bifurcated radial-canals, or 8 to 10 simple radial-canals, or with both simple and bifurcated radial-canals. With a tentacle at foot of each radial-canal. These tentacles branch dichotomously or complexly, and branches end in suckers or nematocyst-knobs. With simple, unbranched, oral tentacles. No brood-sac above stomach. Hydroid, *Stauridia* Dujardin.

*Dendronema* HAECKEL, 1879. With bifurcated radial-canals, and dichotomously branched tentacles. Branches end in suckers, or in nematocyst-knobs. Mouth surrounded by 4 groups of dichotomously branched oral tentacles. There is an apical sac above the stomach.

## Genus ZANCLEA Gegenbaur, 1856.

*Zanclea*, GEGENBAUR, 1856, Zeit. für wissen. Zool., Bd. 8, p. 229.—KEFERSTEIN UND EHLERS, 1861, Zool. Beitr. in Neapel und Messina, p. 85.—AGASSIZ, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 344.

*Zanclea* + *Gemmaria*, HAECKEL, 1879, Syst. der Medusen, pp. 102, 103.

*Zanclea*, FEWKES, 1881, Bull. Mus. Comp. Zool., vol. 8, p. 150.—HARTLAUB, 1887, Zool. Anzeiger, Bd. 10, p. 654; 1907, Nordisches Plankton, Nr. 12, p. 112.—VANHOFFEN, 1891, Zool. Anzeiger, Jahrg. 14, p. 445. -GUNTHER, 1903, Mitt. Zool. Sta. Neapel, Bd. 16, p. 57.

*Gemmaria* = *Zanclea*, BROWNE, 1905, Proc. Roy. Soc. Edinburgh, vol. 25, p. 750.

*Gemmaria*, MCCRADY, 1857, Gymn. Charleston Harbor, p. 49.- -AGASSIZ, A., 1865, North Amer. Acal., p. 184.—ALLMAN, 1872, Monog. Tubul. Hydroids, p. 289.—BROWNE, 1896, Proc. Zool. Soc. London, p. 461.

*Non Gemmaria*, FEWKES, 1881, Bull. Mus. Comp. Zool. at Harvard College, vol. 8, p. 150.

*Gemmaria*, HARTLAUB, 1887, Zool. Anzeiger, Bd. 10, p. 654.—GÜNTHER, 1903, Mitt. Zool. Sta. Neapel, Bd. 16, p. 57.

*Gemmaria* (hydroid), HARTLAUB, 1905, Zoologischen Jahrbuch., Supplement 6, p. 527.

*Cornitis*, MURRACH, 1899, Quart. Journ. Microscop. Sci., new ser., vol. 42, p. 354.- -NUTTING, 1901, Bull. U. S. Fish Commission for 1899, pp. 329, 372.—HARGITT, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 42.

*Halocharis* (hydroid), AGASSIZ, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 239, plate 20, figs. 10–10c.

*Gemmaria* + *Zanclea*, HARGITT, 1908, Biol. Bulletin, vol. 14, p. 104.

The type species of this genus is *Zanclea costata* Gegenbaur, 1856, of the Mediterranean.

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*Tabular Description of the Medusæ of Zanclea.*

| | Z. costata Gegenbaur, 1856. | Z. gemmosa McCrady, 1857. | Z. implexa Allman, 1864. | Z. cladophora = Gemmaria cladophora A. Agassiz, 1865. |
|---|---|---|---|---|
| Shape and size of bell in mm. | Ellipsoidal. 4 to 5 high, 3 to 4 wide. | Pyriform. 6 high, 4 wide. | Dome-like to globular. 1.5 high, 1.75 wide. | Pyriform. Size (?) |
| Length of the 4 meridional rows of nettle-cells above tentacle-bulbs, in terms of bell-height. | From tentacle-bulbs to very near apex of bell. | One-fourth to one-third distance from margin to apex. | 0.25 to 0.5 | 0.5 |
| Number and length of tentacles in terms of bell-radius ($r$). | 4 tentacles, each 3 to 4 $r$ long. | 4 tentacles, each 3 to 4 $r$ long. | 2 to 4 tentacles, each about 4 $r$ long. | 2 long and 2 short tentacles; long tentacles 4 $r$, short over one-third $r$ long. |
| Character of abaxial filaments upon tentacles. | Very numerous, slender, and ending in a spherical capsule containing 3 to 5 nematocysts. | Very numerous, slender, and ending in a spherical capsule containing 3 to 9 nematocysts. | Very numerous, slender filaments, each ending in an oval capsule containing 4 to 8 nematocysts. | Very numerous, slender filaments, ending in knob-like clusters of nematocysts. Number of nematocysts in each knob? |
| Length and shape of manubrium. | Not quite half as long as depth of bell-cavity. Flask-shaped. | Flask-shaped, 4-sided. As long as depth of bell-cavity. Mouth with 4 small lips. | Urn-shaped. Only half as long as depth of bell-cavity. Mounted upon short peduncle. Mouth round opening. | Conical. 4 prominent lips. |
| Gonads. | 4 interradial masses of eggs on swollen sides of stomach. | On 4 interradial sides of stomach. Much swollen. | On upper sides of stomach, more or less separated in 4 chief radii. | Gonad encircles stomach. |
| Color. | Gonads red, tentacles yellowish-brown. | Entoderm of stomach and tentacle-bulbs creamy-pink. Entoderm of manubrium delicate green. | Stomach and tentacle-bulbs brownish-red to crimson. Entoderm of tentacles orange. | Tentacles light-brown. Orange and yellow spots in tentacle-bulbs. Color of stomach (?) |
| Where found. | Mediterranean. Common. Medusa having only 2 tentacles, but in other respects similar to Z. costata found at Tortugas, Florida. | West Indies northward to Woods Hole. | Atlantic coasts of western Europe to Mediterranean. | Coast of Massachusetts, Nahant, Woods Hole. |
| Hydroid. | Hydroid (?) (see text). | Hydroid: Gemmaria gemmosa. | Hydroid: Gemmaria implexa. | Hydroid unknown. |

GENERIC CHARACTERS.

Cladonemidæ with 4 simple radial-canals, and 2 to 4 radially situated tentacles which give rise to filiform, knobbed, nematocyst-bearing side branches. The gonad is developed upon the sides of the stomach. There is no apical brood-pouch above the stomach. There are meridional lines of nettle-cells over the exumbrella. There are no tentacular ocelli. The hydroid is *Gemmaria* Allman, 1871.

In 1857, McCrady founded the genus *Gemmaria* for a *Zanclea*-like medusa with only 2 tentacles. Vanhöffen, 1891, and Browne, 1905, have observed that the 2-tentacled young of other species of these medusæ often becomes 4-tentacled when adult, and according to Browne, 1905, "*Gemmaria*" *implexa* may become mature with 2 or with 4 tentacles. It is evident, therefore, that there are no definite generic distinctions between *Zanclea* and *Gemmaria*, the "*Gemmaria*" condition being only a developmental or retarded phase of *Zanclea*.

Murbach and Nutting have erroneously applied the name "*Corynitis*" to a 2-tentacled medusa of *Zanclea*. Apparently these authors had not seen the medusa of *Corynitis*, which is

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well figured by McCrady. I have frequently taken *Corynitis* in Charleston Harbor, South Carolina, where McCrady discovered it, and it is wholly different from any "*Gemmaria*" or *Zanclea*. (See also Hargitt, 1908.)

The common *Zanclea* of the southern coast of New England, in America, may become mature with only 2 tentacles, and with poorly developed lips. On the other hand, a very similar medusa is occasionally found in the same waters with 4 tentacles and with 4 well-developed lips. I am inclined to believe that these conditions represent developmental stages, or starved and well-fed states of one and the same medusa.

### Zanclea costata Gegenbaur.

Plate 8, figs. 2, 3, 6, and 7.

*Zanclea costata*, GEGENBAUR, 1856, Zeit. für wissen. Zool., Bd. 8, p. 229, taf. 8, figs. 4–7.—HAECKEL, 1879, Syst. der Medusen p. 103.
Hydroid (?), MAYER, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 35, plate 41, figs. 137, 138.

Gegenbaur found many specimens of this medusa in the Mediterranean. His fully developed medusæ had 4 long, equally developed tentacles. For details see tabular description of the medusæ of *Zanclea*.

I have found a medusa at Tortugas, Florida, which accords well with *Zanclea costata*, excepting that it has but 2 tentacles.

*Medusa from Tortugas, Florida.*—Bell 6 mm. high and ellipsoidal, with bluntly-rounded apex. Without an apical projection. Bell-walls of uniform thickness everywhere. There are 2 long, spindle-shaped, rough-looking tentacles somewhat longer than the bell-height. These are thickly covered with papillæ and beset on their outer sides with a row of filaments, each of which ends in a spherical knob, the surface of which is covered with blunt papillæ. Each of these knobs contains a cluster of nematocysts (plate 8). Basal bulbs of tentacles are elongate, spindle-shaped, and hollow. No traces of tentacle-bulbs 90° away from the 2 long tentacles. 4 swollen lines of nematocysts extend upward over the exumbrella from the bases of the 4 radial-canals and nearly meet near the apex of the bell. Velum well developed. 4 radial-canals, and the circular vessel straight and narrow. Manubrium flask-shaped, with 4 simple lips. Entoderm of the manubrium and tentacles milky white, There were 4 interradial gonads. A single specimen was found in a surface-tow at Tortugas, Florida, on May 15, 1906.

FIG. 41.—*Zanclea costata*, from the Mediterranean, after Gegenbaur, in Zeit. für wissen. Zool., Bd. 8.

This species is distinguished by its ellipsoidal, high, rounded bell, without a sharp-pointed apex, the 4 very long meridional lines of nematocysts over the exumbrella, and the spherical nematocyst-capsules at the ends of the tentacular filaments.

The Tortugas medusa differs from *Zanclea costata*, as described by Gegenbaur, in having but 2 tentacles. It is well known, however, that in *Zanclea* some individuals of the same species develop 4 while others become mature with but 2 tentacles.

Gegenbaur states that the female gonads are red (pink ?). In the Tortugas specimen the male gonads were milky-yellowish white.

*Hydroid* (plate 8, fig. 2).—That which is probably the hydroid stock of this species was found by Mayer, 1900, at Tortugas, Florida, and erroneously ascribed to *Zanclea gemmosa;* but Murbach, 1899 (Quart. Journ. Micros. Sci., New Series, vol. 42, p. 354), describes and figures the hydroid of *Zanclea gemmosa*, and it is now evident that the form described by Mayer is specifically distinct from *Z. gemmosa* and is probably *Zanclea costata*, the medusa of which occurs at Tortugas.

*Hydroid of Zanclea costata (?).*—The hydrorhiza is creeping, tubular, and net-like, and gives rise at irregular intervals to short, more or less twisted hydrocauli. Both the hydrorhiza and hydrocauli are covered with a horny, chitinous perisarc, which is annulated in the hydro-

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caulus. The hydrocaulus is corrugated and opaque in color throughout its length, and in this respect differs from the European *G. implexa* Allman, 1871. The fully developed hydranths are only 1.5 mm. in height. They are elongate, spindle-shaped, and taper gradually from near the base to the summit, so that the diameter near the mouth is less than that near the base. The tentacles arise in 5 to 8 well-defined whorls from sides of hydranth, each whorl consisting of 4 to 6 tentacles. These tentacles are short and taper from base to end, terminating in a large knob containing nematocysts. The entodermal cores of the tentacles are composed of vacuolated cells. The tentacles are stiff and project rigidly outward from the sides of the hydranth. 4 to 8 medusa-buds in various stages of development arise from the sides of the hydranth near the base immediately below the lowest whorl of tentacles.

When set free the young medusa (plate 8, fig. 3) has 2 well-developed, radially situated, diametrically opposed tentacles, and 2 rudimentary tentacle-bulbs. There are 4 radially situated, nematocyst-bearing ridges upon the exumbrella, and these extend about half-way up the sides of the bell. The bell-walls are very thin and flexible. There are 4 straight, narrow radial-canals, and the manubrium is a short, simple tube with no trace of the gonad. The mouth is a simple, round opening. Before being set free the tentacles are coiled inward so as to lie within the bell-cavity. Soon after the medusa has become liberated, however, the tentacles uncoil and project outward. The deep-lying entoderm of the hydranths is a delicate creamy-pink, while the more superficial entoderm is translucent and milky in color. The cells of the superficial entoderm are large and vacuolated. The hydrorhiza and hydrocaulus is protected by a horny, yellow, amber-colored, chitinous sheath, but this does not extend over the hydranths. The hydroid was found at Tortugas, Florida, in June, 1899, growing upon a piece of floating gulfweed (*Sargassum*).

### Zanclea gemmosa McCrady.

Plate 6, fig. 7; plate 7, fig. 5; plate 8, figs. 4 and 5.

*Gemmaria gemmosa*, McCrady, 1857, Gymn. Charleston Harbor, p. 49.
*Zanclea gemmosa*, McCrady, 1857, Gymn. Charleston Harbor, p. 49, plate 8, figs. 4, 5.—Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 344.—Hartlaub, 1907, Nordisches Plankton, Nr. 12, p. 121, fign. 116, 117.
*Gemmaria gemmosa*, Agassiz, A., 1865, North Amer. Acal., p. 184, fig. 306.—Haeckel, 1879, Syst. der Medusen, p. 104.—Fewkes, 1881, Bull. Mus. Comp. Zool. at Harvard College, vol. 8, No. 8, p. 150, plate 1, figs. 8–12.—Fewkes, 1884, American Naturalist, vol. 18, p. 196, fig. 2.
*Corynitis agassizii* (hydroid), Murbach, 1899, Quart. Journ. Micr. Sci., vol. 42, p. 354, plate 34, fig. 12 (medusa, figs. 11, 13, 14.)
*Gemmaria sagittaria*, Haeckel, 1879, Syst. der Medusen, p. 103, taf. 7, figs. 3, 4 (young medusa).
*Zanclea gemmosa* (hydroid), Wallace, 1908, Carnegie Institution Year Book, No. 7.

*Adult medusa*.—Bell 6 mm. in height, and pyriform. There is a well-developed, solid, apical projection. Side walls quite thin. There are 4 long, radially situated tentacles with large, hollow basal bulbs, which lack ocelli. The shafts of the tentacles are crowded with large numbers of short filiform branches, which arise only from the dorsal (exumbrella) side of the tentacles, although the twisting of the tentacle may cause them to appear to arise from all sides. Each of these filiform branches terminates in a large spear-head-shaped body which bears a number of long, delicate, sharp-pointed bristles, and which contains 3 to 9 egg-shaped nematocyst-cells. A club-shaped swelling extends longitudinally from the base of each tentacle a short distance up the side of the exumbrella. These swellings are thickly covered with nematocysts. There are 4 straight, slender radial-canals, and a narrow circular vessel. The velum is wide and delicate. The manubrium is flask-shaped, and cruciform in cross-section and extends to the level of the velar-opening. The mouth is a simple, cruciform opening without prominent lips. The gonad is upon the sides of the stomach. These sides are greatly swollen and give to the manubrium its flask-shaped appearance. The entoderm of the manubrium and tentacles is of a delicate creamy-pink and the ectoderm of the manubrium is of a delicate shade of green.

*Young medusa* (plate 7, fig. 5; plate 8, figs. 4, 5).—In the medusa, 1 mm. in height, there are but 2 marginal tentacles. The bell-walls are very thin and the manubrium is a simple fusiform tube. There is no apical projection to the bell, and no trace of gonads upon the manubrium, and the mouth is a simple, round opening without cruciform lips.

This species extends from the West Indies to the southern coast of New England. It is quite common in Newport Harbor late in the summer.

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The hydroid stock has been described by Murbach under the name of "*Corynitis agassizii*," but is evidently a *Gemmaria*. The hydranths are 1.5 to 2 mm. in length and arise singly from a slender, thread-like, anastomosing hydrorhiza. The hydrorhiza is covered with a delicate perisarc, but this does not extend over any part of the hydranths. In this respect the species is very different from *Z. costata*. The hydranths are also more cylindrical and uniform in width throughout the polypite than in *Z. costata*. The tentacles are irregularly arranged and the medusa-buds are found not only near the base of the hydranth, but scattered along the sides. In *Zanclea costata* they are confined to a zone immediately under the lowest circlet of tentacles. The color of both forms is quite similar, excepting that the hydrorhiza is deep pink in the *Z. gemmosa* and rosin-yellow in the *Z. costata*. W. S. Wallace found this hydroid growing upon floating *Sargassum* at Tortugas, Florida, in July, 1908.

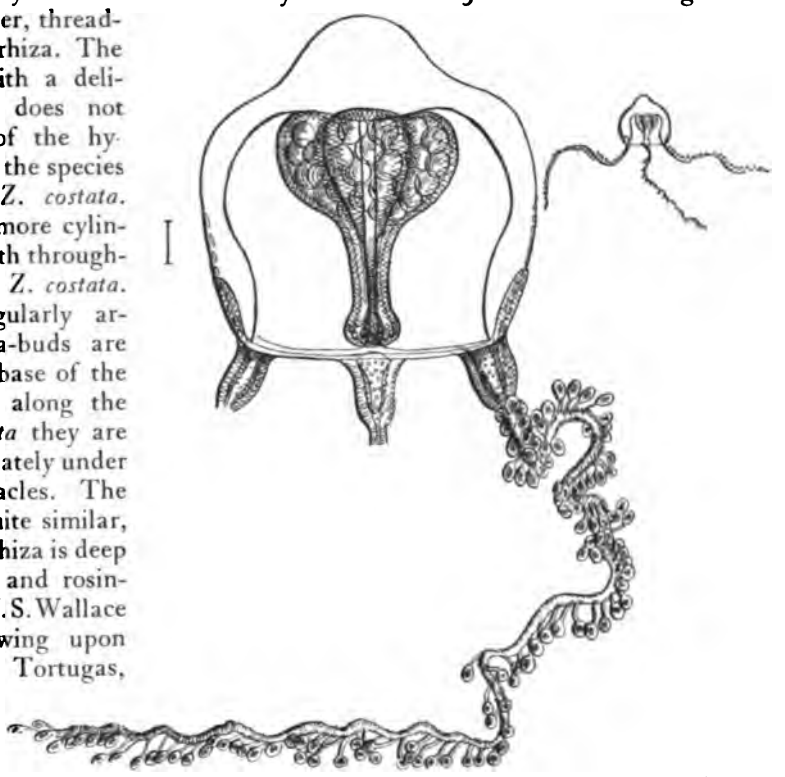

FIG. 42.—*Zanclea gemmosa*, from Fewkes, in Bull. Mus., Comp. Zool. at Harvard College.

The young medusa here figured was obtained at Newport, Rhode Island, and was identified by Dr. Alexander Agassiz as the young of *Zanclea gemmosa*.

*Z. gemmosa* readily devours the medusæ of *Obelia*.

### Zanclea implexa Allman.

*Coryne pelagica*+*Coryne implexa* (hydroid and medusa), ALDER, 1857, Catalogue Zoophytes Northumberland, Trans. Tyneside Nat. Field Club, vol. 3, pp. 13, 18 (of the "separate"), plate 7, figs. 1–6.

*Zanclea implexa*, ALLMAN, 1864, Annals and Mag. Nat. Hist., vol. 13, p. 357.—HINCKS, 1868, Hist. British Hydroid Zoophytes, p. 59, plate 9, fig. 3.—HARTLAUB, 1907, Nordisches Plankton, Nr. 12, p. 116, fign. 106–111 (list of localities, authors, and best description of the medusa).

*Gemmaria implexa*, ALLMAN, 1871–72, Monog. Tubularian Hydroids, pp. 223, 290, plate 7, figs. 1–10.—HAECKEL, 1879, Syst. der Medusen, p. 105.—JICKELI, 1883, Morphol. Jahrbuch, Bd. 8, p. 611, taf. 26 (histology).—GRAEFFE, 1884, Arbeit Zool. Inst. Wien, Bd. 5, p. 353.—BROWNE, 1896, Proc. Zool. Soc. London, p. 461.—HARGITT, 1904, Mitth. Zool. Station Neapel, Bd. 16, p. 574, taf. 22, figs. 27–29 (hydroid and medusa from the Bay of Naples).—BROWNE, 1905, Proc. Roy. Soc. Edinburgh, vol. 25, p. 750.

This medusa is closely related to *Zanclea gemmosa* of the Atlantic coast of the United States, but it is much more swollen than the American form, and differs in other respects.

The bell is globular with fairly thin side walls and a thick, solid, dome-like apex. It is 1.5 mm. high, 1.75 mm. wide. There are 4 prominent nematocyst tracts extending one-fourth to half the distance from the tentacle-bulbs up the sides of the bell, and the nettle-cells in each tract are arranged in two rows.

There are usually 2 long tentacles 180° apart alternating with 2 short tentacle-bulbs, but according to Browne, 1905, the medusa may become mature with 2 or with 4 long tentacles. The long tentacles are about twice as long as the bell-diameter and their upper, abaxial sides bear each a double row of numerous filaments, which terminate in oval capsules containing 4 to 8 nematocysts. The basal bulbs of the tentacles are globular, and lack ocelli.

There is a slight linear (glandular?) swelling occupying the middle third of each of the 4 radial-canals. The stomach is mounted upon a short peduncle and is urn-shaped, with a simple, round mouth-opening. The gonads surround the stomach and are more or less

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separated in the 4 principal radii. The basal bulbs of the tentacles and the stomach are brownish-red to bright crimson, and the entoderm of the tentacles is orange.

This medusa is found off the Atlantic coasts of Western Europe, and in the Mediterranean. Graeffe, 1884, states that at Trieste, Adriatic Sea, the medusæ bud forth from the hydroids in the spring, and a second brood appears to develop in summer.

The hydroid is *Gemmaria implexa*, well described and figured by Allman, 1871–72.

The stems of the hydroid are erect, 6 to 8 mm. high, and arise at intervals from a creeping, net-like hydrorhiza which is attached to shells, stones, etc., in shallow water. The stems are usually single, but occasionally they branch. The perisarc covers the hydrorhiza and extends as a transversely corrugated, opaque tube up the lower part of each hydranth. Below the zones of tentacles the perisarc becomes abruptly smooth, and ends in a slightly flaring cup. The hydranths are cylindrical to club-shaped, with dome-like peristome. There are 40 to 50 short tentacles, each ending in a knob of nematocysts. These tentacles are arranged in 10 to 13 irregular verticils of about 4 tentacles each, the tentacles being about 90° apart. The medusa-buds are borne upon peduncles which arise in clusters from the sides of the hydranth below the middle, but above the lowermost verticils of tentacles.

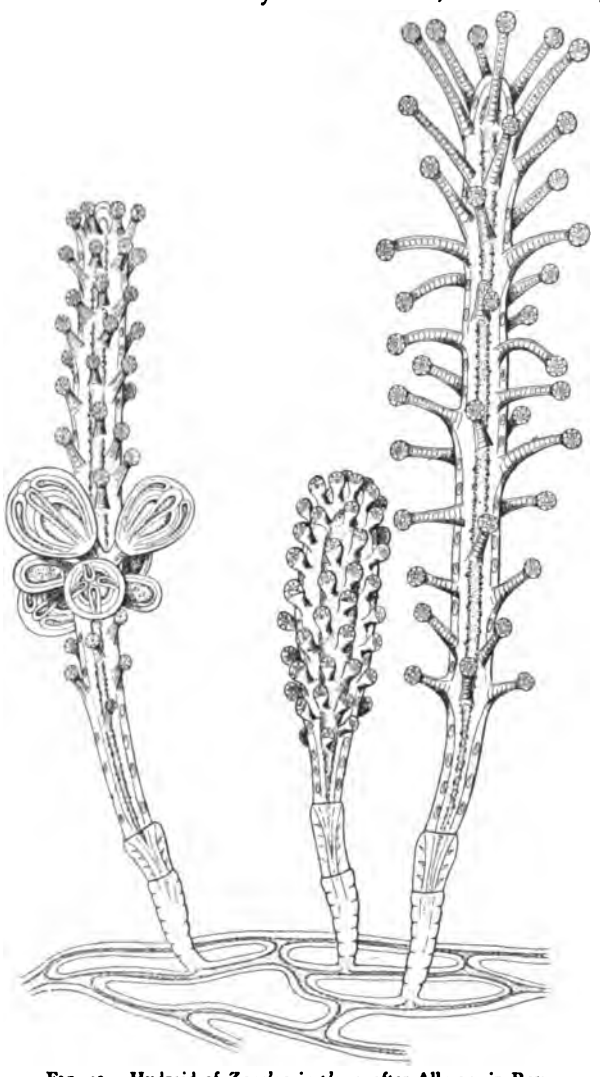

FIG. 43.—Hydroid of *Zanclea implexa*, after Allman, in Ray Society, 1871–72. See also, Fig. 44.

When set free the medusa has 2 well-developed tentacles which give rise to numerous filaments, each ending in a capsule bearing terminal bristles and containing several nematocysts. There are also 2 small tentacle-bulbs 90° apart from the well-developed tentacles. The bell is oval and higher than a hemisphere and 4 lines of nematocysts extend up about one-fourth to one-third of the bell-height, one above each tentacle-bulb. The 4 radial-canals are straight and simple, and the manubrium is a simple tube with a round mouth-opening and straight cylindrical sides. It lacks a peduncle and is about half as long as depth of bell-cavity.

The hydranths are white with pale-pink entoderm. The perisarc on the proximal portion of the hydrocaulus is brown and on the distal portion, colorless. It is closely related to the hydroid of *Zanclea gemmosa*.

**Zanclea cladophora Hartlaub.**

*Gemmaria cladophora*, AGASSIZ, A., 1865, North Amer. Acal., p. 184, figs. 307–310.—HAECKEL, 1879, Syst. der Medusen, p. 104.—NUTTING, 1901, Bull. U. S. Fish Commission for 1899, vol. 19, p. 371, fig. 78.—HARGITT, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 42.

*Zanclea cladophora*, HARTLAUB, 1907, Nordisches Plankton, Nr. 12, p. 121, fign. 112–115.

Bell pyriform and about as broad as high. Apical projection solid, rounded, and dome-like. There are 2 long, diametrically opposed tentacles from the outer sides of which arise a great number of slender filaments, each terminating in a knob-like body which contains

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nematocysts. These long tentacles are 1.5 times as long as the bell-diameter. There are also 2 small, conical tentacles 90° apart from the long ones. The small tentacles do not give rise to side-filaments. No ocelli. A ridge of nematocyst-cells extends from the base of each tentacle about half-way up the side of the exumbrella. Velum broad. There are 4 broad radial-canals and a narrow circular tube. The outline of the bell-cavity does not follow that of the outer surface of the bell, but is widest at the inner apex. Manubrium conical, with a wide proximal base and regularly-narrowing sides. It does not extend quite to the level of the velar opening. The 4 lips are quite prominent, and the mouth is a rectangular opening. The mouth is surrounded by 2 or 3 rows of large nematocyst-cells, similar to those found upon the sides of the exumbrella. The gonad is developed upon the sides of the stomach, which it encircles. The tentacles are light-brown in color, and the entoderm at their bases contains orange pigment. There are bright-yellow pigment-spots at the bases of the two rudimentary tentacles. This species was found at Nahant, Massachusetts, in 1862, by Dr. Alexander Agassiz. Nutting, 1901, obtained it at Woods Hole, Massachusetts, in August, 1899. Neither of these observers states the dimensions of the medusa.

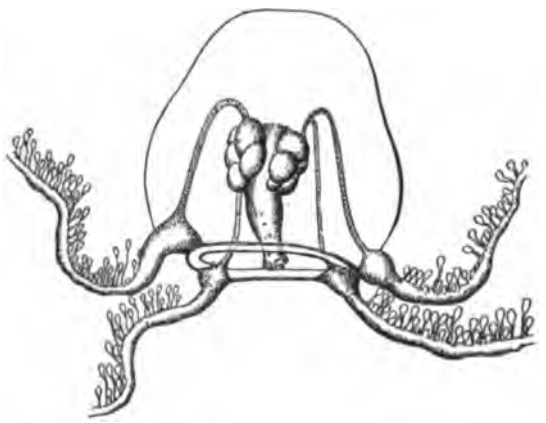

FIG. 44.—*Zanclea implexa*, after Hartlaub, in Nordisches Plankton.

The peculiar outline of the subumbrella and the constriction above the lips figured by A. Agassiz may be due to unnatural contraction.

Many of the characters of this so-called "species" remain in doubt.

**Zanclea nitida.**

*Gemmaria nitida*, HARTLAUB, 1905, Zoolog. Jahrbüchern, Suppl. 6, p. 527, fign. J, H (hydroid).

Polypites about 8 mm. long. Club-shaped to cylindrical, with about 50 short knobbed tentacles, irregularly distributed. Hypostome short and flatly conical. Each polypite bears 1 to 3 clusters of small medusa-buds. These are borne upon short branching stems which arise between the tentacles near the lower, basal part of the polypite. The condition of the medusa is not described. Found at Juan Fernandez Island, off the Pacific coast of South America.

**Genus ZANCLEOPSIS Hartlaub, 1907.**

*Zancleopsis*, HARTLAUB, 1907, Nordisches Plankton, Nr. 12, pp. 115, 116.

GENERIC CHARACTERS.

Cladonemidæ related to *Zanclea*, but with large, stout, lateral branches on the tentacles. With ectodermal ocelli upon the tentacle-bulbs, and without meridional clusters of nematocysts upon the exumbrella.

The type species, and only known form, is *Zancleopsis dichotoma*, from Tortugas, Florida, described by Mayer under the name *Gemmaria dichotoma*.

This genus is distinguished from *Zanclea* by the large lateral branches upon its tentacles, and by the *absence* of nettle-cell tracts upon the exumbrella. Also, it has *ocelli*, and these are not known in *Zanclea*.

**Zancleopsis dichotoma Hartlaub.**

Plate 8, fig. 1.

*Gemmaria dichotoma*, MAYER, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 35, plate 17, fig. 40.
*Zancleopsis dichotoma*, HARTLAUB, 1907, Nordisches Plankton, Nr. 12, p. 115, fig. 105.

Bell miter-shaped, with thin walls, and solid apical projection. 3 mm. high and about 2.5 mm. wide. There are 2 rudimentary tentacle-bulbs and 2 well-developed, diametrically opposed tentacles. These long tentacles are of unequal length, one being about as long as

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the bell-height, while the other is only about two-thirds this length. Each of these tentacles terminates in a club-shaped, nematocyst-bearing end. The small tentacle gives rise to 2 to 3 side branches while the large one gives rise to 4 side branches. These side branches arise from the outer (aboral) side of the tentacle, and each one terminates in a knob-like end containing nematocysts as in the end of the main shaft itself. The youngest and least-developed side branch is always found nearest the side of the bell, whereas the oldest is nearest the outer end of the tentacle. The basal bulbs of the tentacles are large and swollen and contain each an ectodermal ocellus upon the outer (abaxial) side of the bulb. The ectodermal core of each tentacle and of the side branches is hollow. The nematocyst bulbs of the tentacles are provided with delicate bristles. The velum is quite narrow. There are 4 straight, simple radial-canals and a narrow circular vessel. The manubrium is flask-shaped, and cruciform in cross-section, with 4 small, cruciform, nematocyst-covered lips. The stomach-cavity does not project upward into the gelatinous apex of the bell. The gonads are developed upon the interradial sides of the stomach.

The entoderm of the manubrium and the circular and radial-canals is dull ocher-yellow, while the entodermal cores of the terminal bulbs of the tentacles is of a brighter yellow.

The 4 ocelli (2 on the bulbs of the well-developed tentacles and 2 on the rudimentary tentacle-bulbs) are dark reddish-brown.

This medusa is occasionally found at Tortugas, Florida, from May until July. It is taken each year upon the surface, but never in large numbers.

This species is widely separated from other medusæ of the genus *Gemmaria* by its well-developed ectodermal ocelli upon the 4 tentacle-bulbs and by the total absence of nematocyst tracts upon the exumbrella. The "filaments" arising from the abaxial sides of the 2 long tentacles are almost as thick as the main shaft of the tentacle itself, and in comparison with species of *Gemmaria* they are greatly reduced in number. This numerical disparity is, however, counterbalanced by their great size.

## Genus PTERONEMA Haeckel, 1879.

*Microstoma*, preoccupied by CUVIER, 1817, for Fishes.
*Microstoma*, LESSON, 1829, Voyage autour du monde sur la *Coquille*, tome 2, Zooph., p. 130.
*Pteronema*, HAECKEL, 1879, Syst. der Medusen, p. 101.—VANHÖFFEN, 1891, Zool. Anzeiger, Jahrg. 14, p. 445.

The first medusa to be described which belongs to this genus is *Microstoma ambigua* Lesson, from New Guinea.

Haeckel, 1879, describes that which is probably the same medusa, in an expanded state, under the name *Pteronema darwinii*. This species is described from the coast of Australia, but the exact locality is not stated.

### GENERIC CHARACTERS.

Similar to *Zanclea*, but distinguished by having a brood-sac above the stomach, the nature of which is unknown. If it be similar to that of *Eleutheria* it has no connection with the stomach. Haeckel considers it to be continuous with the stomach, but his studies do not demonstrate this to be true, for he cut no sections.

There are no meridional tracts of nematocysts upon the exumbrella in *Pteronema*.

### Pteronema darwinii Haeckel.

(? ?) *Microstoma ambigua*, LESSON, 1830, Voyage de la Coquille, Zooph., tome 2, p. 130, plate 14, figs. 5, 5'.
(? ?) *Microstoma ambiguus*, LESSON, 1843, Hist. Zooph. Acal., p. 295.
(? ?) *Zanclea ambigua*, AGASSIZ, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 344.
*Pteronema darwinii*, HAECKEL, 1879, Syst. der Medusen, p. 101, taf. 7, figs. 1, 2.
(? ?) *Pteronema ambiguum*, BEDOT, 1905, Revue Suisse de Zool., tome 13, p. 144 (literature, 1830–1850).

Haeckel describes his *Pteronema darwinii* from a single specimen preserved in glycerin. He states that the preservation was good, but that the tentacles were contracted and are represented in his figure as being of double the length observed in the preserved specimen. This medusa was obtained somewhere off the coast of Australia.

Lesson, 1830, describes a medusa under the name *Microstoma ambigua* from Waigion, New Guinea, which may possibly be identical with *P. darwinii*. Lesson's description is,

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however, too vague to be of service, and his figure 5′ is almost equally hopeless. The spherical bell is apparently turned inside out, and there are 4 short, feathered, marginal tentacles and a flaring, conical manubrium, the tentacles and manubrium being bright yellow. His figure 5 is even worse for purposes of identification. I advise the dropping of Lesson's medusa from future lists, for it will doubtless be impossible to determine it even generically.

In Haeckel's medusa the bell is 6 mm. high, 4 mm. wide, pyriform with a pointed conical apex. There are no longitudinal lines of nematocysts over the exumbrella. There are 4 radially placed marginal tentacles, longer than the bell-height, and each provided with an abaxial row of filiform side branches, each one of which terminates in a spear-head-shaped capsule containing 5 to 10 nettle-cells. The basal bulbs of the tentacles are conical and lack ocelli. There are 4 straight, wide, jagged edged radial-canals and a narrower, smooth edged circular vessel. The stomach is spindle-shaped, half to two-thirds as long as the depth of the bell-cavity, and provided with 4 simple lips. Gonads (?) on the adradial sides of the stomach.

FIG. 45.—*Pteronema darwinii*, after Haeckel, 1879.

The distinguishing characteristic of this medusa is the elongate, spindle-shaped brood-pouch above the stomach in the gelatinous apex of the bell. Haeckel observed ripe eggs and gastrulæ in this brood-pouch. The anatomical relationships between this brood-pouch and the stomach are unknown, and it may have no connection with the stomach, but be ectodermal and connected with the subumbrella epithelium as it is in *Eleutheria*. Haeckel's description affords no solution of this problem. Color (?) Coast of Australia. Exact locality unknown. A single specimen described by Haeckel.

### Genus ELEUTHERIA Quatrefages, 1842.

*Eleutheria*, QUATREFAGES, 1842, Compt. rend. Acad. Sci., Paris, tome 15, p. 168; 1842, Annal. des Sci. Nat., série 2, tome 18, p. 270.

*Clavatella* (hydroid and medusa), HINCKS, 1861, Annals and Mag. Nat. Hist., ser. 3, vol. 7, p. 73.

*Eleutheria*, KROHN, 1861, Wiegemann's Archiv. für Naturges., Jahrg. 27, Bd. 1, p. 157.—CLAPARÈDE, 1863, Beobacht. über wirbellose Thiere, p. 4.—ALLMAN, 1872, Monog. Tubul. Hydroids, p. 384.—HAECKEL, 1879, Syst. der Medusen, p. 105.—HARTLAUB, 1886, Zool. Anzeiger, Bd. 9, p. 707; *Ibid.*, 1887, Bd. 10, p. 652; *Ibid.*, Bd. 12, p. 665, 1889; 1907, Nordisches Plankton, Nr. 12, p. 126.—BROWNE, 1902, Annals and Mag. Nat. Hist., ser. 7, vol. 9, p. 279.—GÜNTHER, 1903, Mitt. Zool. Sta. Neapel, Bd. 16, p. 57.—KRUMBACH, 1907, Zool. Anzeiger, Bd. 31, p. 450.

The type species of this genus is the extremely variable *Eleutheria dichotoma* of the Mediterranean and Atlantic coasts of Europe. Haeckel, 1879, p. 106, records 12 subspecies of this medusa. The best description is by Hartlaub, 1886, 1907.

#### GENERIC CHARACTERS.

Cladonemidæ with 4 or more simple radial-canals and an equal number of bifurcated tentacles. Terminal branches of tentacles end each in a knob-like cluster of nematocysts. Manubrium a simple, 4 or more sided tube without oral tentacles or prominent lips. Velum well developed and there is an urticating ridge around the exumbrella side of the bell-margin below the ring-canal. There is a peculiar brood-pouch above the stomach, but this pouch is not connected with the gastrovascular cavity of the medusa. The cavity of this brood-pouch is, however, connected with the bell-cavity by means of simple, interradial openings. The genital products are developed exclusively in the epithelial lining of this brood-pouch, which is derived

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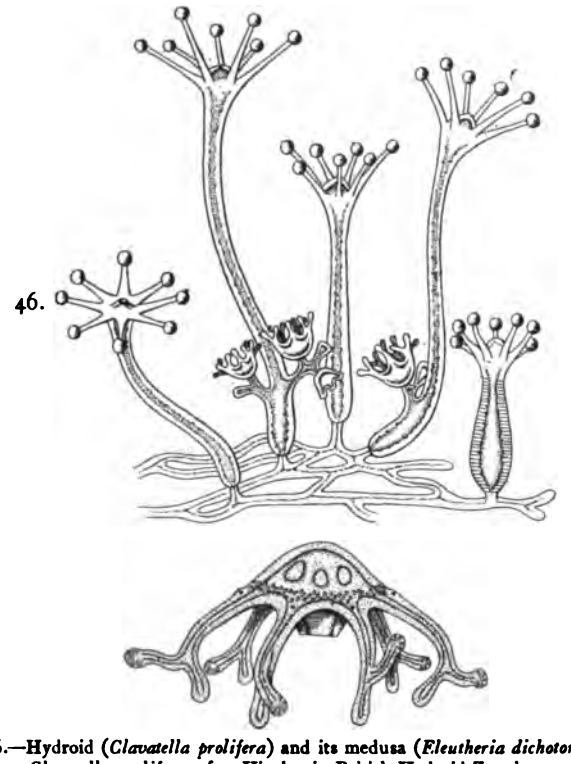
from the ectoderm of the subumbrella cavity of the bell. The medusa is hermaphroditic; ova develop in the ventral, and sperm in the dorsal (aboral) wall of the brood-pouch.

The hydroid is *Clavatella* of Hincks, 1861 (Annals and Mag. Nat. Hist., ser. 3, p. 73, plates 7, 8; *Ibid.*, 1868, British Hydroids, vol. 1, p. 73, plate 12, fig. 2). In *Clavatella* the polypites arise singly from a linear stolon. The polypites are small linear, or clavate, with a zone of 8 slender tentacles which terminate each in a knob of nematocysts. The medusa-buds are borne only on two opposite sides of the body of the polypite near its base. The hydroid lives on *Ulva* in shallow tide pools, and the medusæ are produced in summer and autumn.

Hartlaub found that the entoderm of the planula of *Eleutheria* contains numerous nematocyst-cells. Krumbach, 1907, believes that *Trichoplax*, F. E. Schulze, 1891 (Abhandl. Akad. Berlin), is the creeping planula of *Eleutheria*.

*Eleutheria*, *Cladonema*, and *Amphogona* are the only genera of hydromedusæ known to be hermaphroditic.



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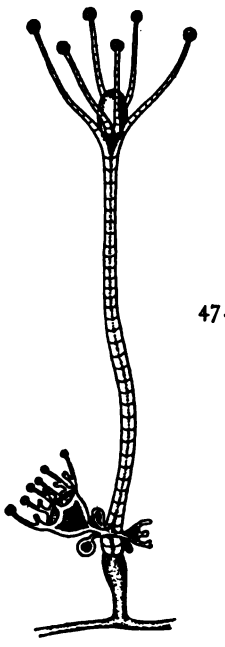

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FIG. 46.—Hydroid (*Clavatella prolifera*) and its medusa (*Eleutheria dichotoma*), after Allman, in Ray Society, 1871, 1872.
FIG. 47.—*Clavatella prolifera*, after Hincks, in British Hydroid Zoophytes.

**Eleutheria dichotoma Quatrefages.**

*Eleutheria dichotoma*, QUATREFAGES, 1842, Compt. rend. Acad. Sci., Paris, tome 15, p. 168; 1842, Annales Sci. Nat., Ser. 2, p. 270, plate 18.—KROHN, 1861, Archiv. Naturgesch., Jahrg. 27, p. 157.
*Clavatella prolifera* (hydroid), HINCKS, 1861, Annals and Mag. Nat. Hist., ser. 3, vol. 7, p. 73, plates 7, 8; 1868, Hist. British Hydroid Zoophytes, p. 73, plate 12, fig. 2.
*Non Eleutheria dichotoma*, CLAPARÈDE, 1863, Beob. Anat. und Entwick. wirbelloser Thiere, p. 4, taf. 1, fign. 4–10.
*Clavatella prolifera* (hydroid), ALLMAN, 1872, Monog. Tubul. Hydroids, pp. 31, 212, 384, plate 18.
*Eleutheria dichotoma* (*non* claparède), HAECKEL, 1879, Syst. der Medusen, p. 106.
*Eleutheria dichotoma*, GRAEFFE, 1884, Arbeit. Zool. Inst. Wien, Bd. 5, p. 353.—HARTLAUB, 1886, Zool. Anzeiger, Bd. 9, p. 706, 1 fig. Also: *Ibid.*, 1887, Bd. 10, p. 652; 1907, Nordisches Plankton, Nr. 12, p. 127, fign. 119, 120.—BEDOT, 1905, Revue Suisse de Zool., tome 13, p. 133 (literature cited to 1850).—MÜLLER, 1908, Zeit. für wissen. Zool., Bd. 89, pp. 34, 73, taf. 3, fign. 3–7 (origin and structure of eggs).

This medusa is exceedingly variable, but the normal form may be briefly described as follows:

Bell irregularly hemispherical, with its lower surface more or less 6-sided. 0.3 to 0.4 mm. wide. There is a ridge of large nettling warts extending around the margin. There are 6 tentacles at the ends of the 6 short radial-canals, and *not* irregularly arranged in reference to the radial-canals as in *E. claparedii* Hartlaub = *E. dichotoma* Claparède.

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Each tentacle bifurcates and is twice as long as the bell-diameter. The 2 terminal branches end one in an adhesive disk, and the other in a large, knob-like cluster of nettle-cells. These branches are not quite as long as the basal shaft of the tentacle itself. An abaxial ocellus is found at the base of each tentacle.

The medusa is hermaphroditic, and the sexual products are developed in an ectodermal brood-pouch above, but not connected with, the stomach. The cavity of the brood-pouch is connected with the bell-cavity by means of 6 simple, interradial openings which alternate with the 6 radial-canals. Sperm develops in the aboral, and ova in the oral (lower) wall of the brood-pouch.

Medusa-buds are also produced upon the exumbrella side of the ring-canal, and this process is usually associated with the sexual reproduction. The terminal suckers of the tentacles are orange or yellowish-brown. Stomach and canals yellowish.

This medusa is found clinging to green sea-weeds off the Atlantic coasts of Belgium, England, and France, and is widely distributed in the Mediterranean. Graeffe, 1884, found it to be common upon *Ulva* from July to September at Trieste, Adriatic Sea. The budded medusæ become sexually mature in 3 to 4 weeks. The planula larva creeps over the sea-weeds.

Detailed descriptions are given by Quatrefages and Allman, and the best modern account is that of Hartlaub, who discovered the remarkable character of the brood-pouch or ectodermal gonad.

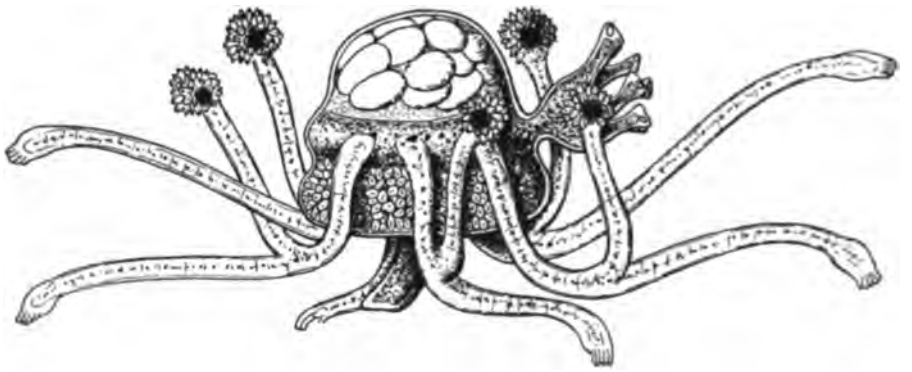

FIG. 48.—*Eleutheria dichotoma*, after Hartlaub, in Nordisches Plankton.

The hydroid is *Clavatella prolifera* Hincks (see definition of the genus *Eleutheria*).

*Eleutheria dichotoma* is apparently quite variable. The tentacles and radial-canals, although normally 6, may range from 4 to 8. Haeckel, 1879, p. 106, designates these aberrations as "subspecies," and gives specific names to twelve of them, although a number of these should be credited to *Eleutheria claparedii* Hartlaub and its variations.

Hartlaub finds that the ova develop into planula larvæ within the brood-sac before being set free.

Müller, 1908, studied the origin and structure of the eggs of this medusa. The eggs are small, numerous, and oval in outline, not amœboid. There is no visible distinction between exoplasm and endoplasm. The ooplasma is a network of very fine fibers. There are numerous small yolk-granules.

### Eleutheria claparedii Hartlaub.

*Eleutheria claparedii*, HARTLAUB, 1889, Zool. Anzeiger, Bd. 12, p. 665; 1907, Nordisches Plankton, Nr. 12, p. 129, fig. 121.
*Eleutheria dichotoma*, CLAPARÈDE, 1863, Beobacht. Anat. und Entwicklungsges. wirbelloser Thiere, p. 4, taf. 1, figs. 4-10. – SPAGNOLINI, 1876, Catalogo Acalefi Mediterraneo, p. 24, tav. 4, fig. 2.

Bell 0.4 to 0.5 mm. wide, irregular in shape, usually more or less hemispherical (fig. 49). A ring of nettling warts on bell-margin. 8 to 10 tentacles, irregularly arranged in reference to the 4 to 6 radial-canals. A small abaxial ocellus at the base of each tentacle. The tentacles are 3.5 times as long as the bell-diameter, and they bifurcate at their extremities; one branch ends in an adhesive disk, and the other in a nettling knob. About 6 or 7 medusa-buds are produced upon the subumbrella side of the ring-canal and project into the bell-cavity.



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This process of budding is independent of the sexual reproduction. The terminal suckers of the tentacles are orange. Found on *Ulva* in the Bay of Naples. Described in detail by Hartlaub. The structure of the reproductive sac is discussed in describing the character of the genus *Eleutheria*.

**Eleutheria vallentini Brown.**

*Eleutheria vallentini*, BROWNE, 1902, Annals and Mag. Nat. Hist., ser. 7, vol. 9, p. 279.

Umbrella hemispherical, 3 mm. wide, 2 mm. high. 24 tentacles divided into two branches, the upper branch with clusters of nematocysts, the lower with a terminal sucker. "An ocellus on the extreme margin of the umbrella opposite each tentacle." Stomach-tube conical and small. Mouth a plain round opening without lips. The gonads occupy "the whole of the upper part of the umbrella above the stomach." A single specimen was found by Vallentin at

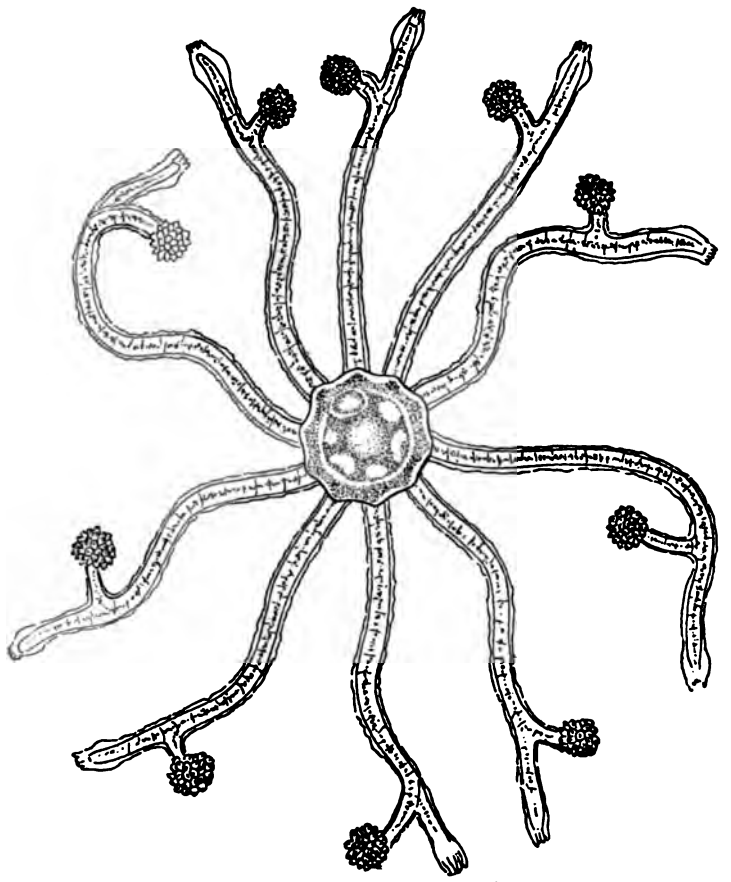

FIG. 49.—*Eleutheria claparedii*, after Hartlaub, in Nordisches Plankton.

Stanley Harbor, Falkland Islands, and described by Browne. Color (?) Number of radial-canals (?) Brood-pouch (?) In the absence of a figure or a more detailed description it will probably be impossible to redetermine this form unless it be rediscovered in Stanley Harbor.

**Genus MNESTRA Krohn, 1853.**

*Mnestra*, KROHN, 1853, Archiv. für Naturges., Jahrg. 19, p. 278.—GÜNTHER, 1903, Mittheil. Zool. Sta. Neapel., Bd. 16, p. 35.

The type species is *Mnestra parasites* Krohn, from the Mediterranean.

GENERIC CHARACTERS.

Cladonemidæ with 4 radial-canals and a ring-canal. No brood-sac above the stomach. 4 to 0 degenerate, hollow tentacles with a row of netting capsules along their aboral sides. With a ring of nettling cells around the margin and 4 linear tracts of nematocysts over the

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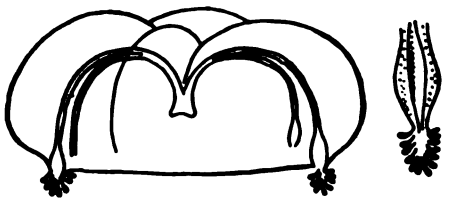
exumbrella, one above each of the 4 tentacle-bulbs. The throat of the medusa is blocked by a spongy mass of entoderm. There is a cup-like depression in the center of the exumbrella.

This medusa attaches itself by its suctorial mouth to the throat of the opisthobranch mollusk, *Phyllirhoë*. It may be derived from some Zanclea-like form which has become degenerate through its sessile habits. It can not swim, yet it has well-developed circular muscles in the subumbrella and a distinct velum.

**Mnestra parasites Krohn.**

*Mnestra parasites*, KROHN, 1853, Archiv. Naturges., Jahrg. 19, p. 278.—CLAUS, 1875, Verhandl. Zool. Botan. Gesell., Wien, Bd. 25, p. 9, taf. 1.—HAECKEL, 1880, Syst. der Medusen, p. 653.—GÜNTHER, 1903, Mittheil. Zool. Sta. Neapel, Bd. 16, p. 35, plates 2, 3, 42 figs.
*Mnestra parasitica*, FEWKES, 1884, American Naturalist, vol. 18, p. 197, figs. 4, 5.



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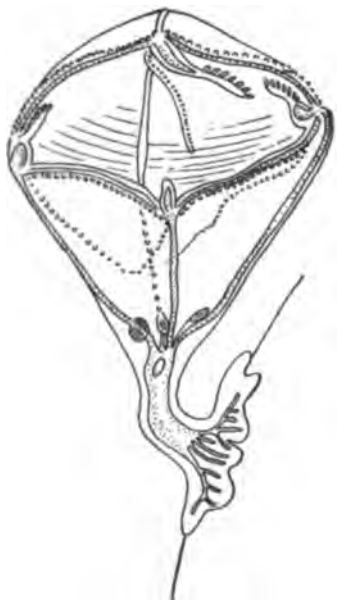

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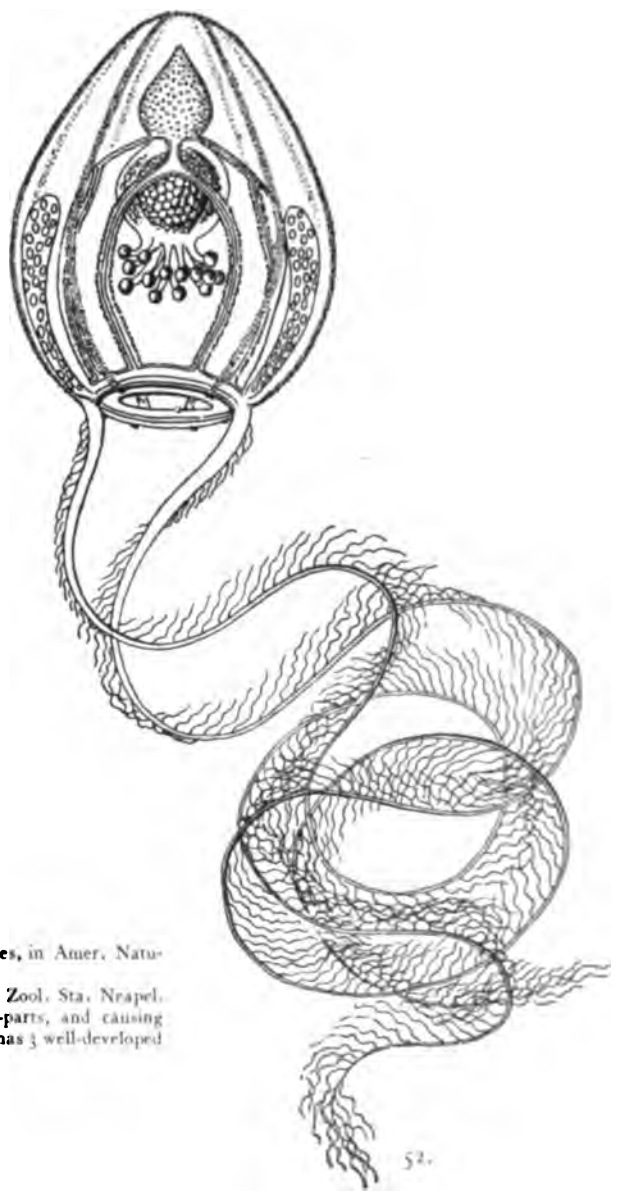

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FIG. 50.—*Mnestra parasites*, from Florida, after Fewkes, in Amer. Naturalist, 1884.
FIG. 51.—*Mnestra parasites*, after Günther, in Mitth. Zool. Sta. Neapel. Bell turned inside out, showing mouth-parts, and causing exumbrella to be cup-shaped. Medusa has 3 well-developed tentacles.
FIG. 52.—*Ctenaria ctenophora*, after Haeckel, 1879.

This minute, degenerate, highly variable medusa is parasitic or commensal upon the mollusk *Phyllirhoë*. Its germ cells appear to migrate into the body of the *Phyllirhoë* where they develop.

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It has been rescued from scientific oblivion through an able paper by Günther, 1903, who has carried out an elaborate study of its anatomy, life-history, and variations.

The characters of the medusa are those of the genus of which it is the sole representative (see genus *Mnestra*).

Fewkes, 1884, describes this medusa upon *Phyllirhoë* on the Florida Reef. It is common at Naples and Messina, Mediterranean.

### Genus CTENARIA Haeckel, 1879.

*Ctenaria*, HAECKEL, 1879, Syst. der Medusen, p. 107.—GÜNTHER, 1903, Mittheil. Zool. Sta. Neapel, Bd. 16, p. 57.—HARTLAUB, 1907, Nordisches Plankton, Nr. 12, p. 24.

The type species is *Ctenaria ctenophora* Haeckel, from the coast of Japan. This is the sole representative of the genus, and Haeckel had but a single preserved specimen.

#### GENERIC CHARACTERS.

Cladonemidæ with 4 bifurcated radial-canals. With 2 feathered marginal tentacles and simple, unbranched, oral tentacles. There are 8 adradial, meridional lines of nematocysts over the exumbrella, and a nematocyst tract above the base of each marginal tentacle. Gonads on the sides of the stomach. There is an apical cavity above the stomach, but it is not known whether this is an ectodermal brood-pouch, as in *Eleutheria*, or a mere extension of the stomach-cavity.

### Ctenaria ctenophora Haeckel.

*Ctenaria ctenophora*, HAECKEL, 1879, Syst. der Medusen, p. 108, taf. 7, figs. 5–7.—HARTLAUB, 1907, Nordisches Plankton, Nr. 12, p. 126, fig. 119.

Bell three-fourths-egg-shaped; 6 mm. high, 5 mm. wide. (Fig. 52.) Widest in a zone slightly below the middle. 8 adradial lines of nettling cells extend up the sides of the exumbrella from the margin nearly to the apex, and in addition to these there are 2 large club-shaped clusters of nematocysts extending from the bases of the 2 tentacles half-way up the sides of exumbrella.

The tentacles are each 2 to 4 times as long as the bell-height and they taper gradually from base to tip. There are no basal ocelli. A row of numerous, slender filaments arises from the abaxial side of each tentacle. These filaments superficially resemble those of Ctenophoræ, and do not end in nematocyst capsules as in *Zanclea*. They are, however, covered with nematocysts throughout their lengths.

The velum is well developed. 4 main radial-canals arise from the stomach, but these bifurcate so that 8 canals join the marginal circular vessel in the 8 adradii. The edges of these radial-canals are serrated, being apparently beset with glands.

The stomach is almost spherical and about half as long as the depth of the bell-cavity. There are 16 short, simple, oral tentacles, each of which ends in a nematocyst-knob.

Haeckel describes 4 swollen, radially placed gonads on the sides of the stomach, but these are probably adradial or interradial (?) There is a well-developed apical cavity above the stomach, but it is not quite clear whether this is a brood-sac homologous with that of *Eleutheria* or whether it is simply an apical extension of the stomach. Haeckel supports the latter view, but he made no sections, and the point can not be considered as determined. Color (?)

Haeckel describes this medusa from a single alcoholic specimen from Japan.

### Genus CLADONEMA Dujardin, 1843.

*Cladonema*, DUJARDIN, 1843, Annal. des Sci. Naturelles, tome 20, p. 370.—KROHN, 1853, Müller's Archiv. für Anatomie und Physiologie, p. 420.—GEGENBAUR, 1856, Zeit. für wissen. Zool., Bd. 8, p. 230.—VAN BENEDEN, 1866, Fauna Littor. Belgique, p. 139.—HINCKS, 1868, British Hydroid Zoophytes, p. 62.—ALLMAN, 1871–72, Monograph Tubularian Hydroids, pp. 216, 357.—HAECKEL, 1879, Syst. der Medusen, p. 109.—PERKINS, 1902, Johns Hopkins University Circulars, No. 155, p. 25, 1908, Papers from Tortugas Laboratory Carnegie Institution of Washington, vol. 1, p. 136.—HARTLAUB, 1887, Zool. Anzeiger, Bd. 10, p. 654; 1907, Nordisches Plankton, Nr. 12, p. 131.—GÜNTHER, 1903, Mitt. Zool. Sta. Neapel, Bd. 16, p. 57.

*Stauridium cladonema* (hydroid), DU PLESSIS, 1888, Recueil Zool. Suisse, tome 4, p. 536.

#### GENERIC CHARACTERS.

Cladonemidæ with 4 or 5 or more bifurcated radial-canals or 8 to 10 or more simple canals, or with some bifurcated and some simple canals. With 8 to 10 or more tentacles which

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give rise to sucker-bearing or nematocyst-bearing branches or both. With 4 or 5 simple, oral tentacles which terminate in nematocyst-knobs. There is no brood-sac above the stomach. The genital products develop within the entoderm of the stomach, and when mature are found in the ectoderm. The medusa is sometimes observed to be hermaphroditic.

The type species is *Cladonema radiatum* of the coasts of Europe. According to Haeckel this species is highly variable both in form and color (see Haeckel, 1879, p. 109). The two American forms described by Perkins are, however, quite constant in their form, although one of them is somewhat variable in color. The hydroid stock of *Cladonema* belongs to the tubularian genus *Stauridia* of Dujardin. It is well described by Allman, 1871 (Tubularian Hydroids, pp. 216, 357, plate XVII), and by Perkins, 1908.

**Cladonema radiatum Dujardin.**

*Cladonema radiatum*, DUJARDIN, 1843, Compt. rend. Acad. Sci., p. 1134.
*Stauridie* (hydroid), DUJARDIN, *Ibid.*, p. 1133.
*Cladonema radiatum* and *Stauridie*, DUJARDIN, 1843, Annal. des Sci. Nat., tome 20, p. 370; 1845, *Ibid.*, ser. 2, tome 4, pp. 271 272, plate 14, fig. C.
*Cladonema radiatum*, KROHN, 1853, Müller's Archiv. für Anat. und Physiol., p. 420, plate 13.—KEFERSTEIN UND EHLERS, 1861. Zoologische Beiträge Neapel, Messina, p. 85, taf. 13, fig. 5.—VAN BENEDEN, 1866, Mém. Acad. Roy. Belgique, tome 36, p. 139, plate 12.—HINCKS, 1868, Hist. British Hydroid Zooph., p. 62, plate 11.—ALLMAN, 1872, Monog. Tubul. Hydroids, pp. 216, 357, plate 17, figs. 1–10.—HAECKEL, 1879, Syst. der Medusen, p. 109.—WEISMANN, 1883, Entstehung Sexualzellen, bei Hydromedusen, Jena, pp. 119, 218, taf. 12, figs. 2–5.—JICKELI, 1883, Morphol. Jahrbuch, Bd. 8, p. 602, taf. 26 (histology).—HARTLAUB, 1887, Zool. Anzeiger, Bd. 10, p. 655, 1 fig.; 1907, Nordisches Plankton, Nr. 12, p. 132, figs. 123–125, (list of authors; excellent description of the medusa).—BEDOT, 1905, Revue Suisse de Zool., tome 13, pp. 58, 132 (references to 1850).—BILLARD, 1905, Bull. Muséum d'Hist. Nat. Paris, tome 11, p. 500 (variations). MÜLLER, 1908, Zeit. für wissen. Zool., Bd. 89, pp. 30, 73, taf. 3, figs. 1, 2; taf. 4, figs. 8–11.

Bell half-egg-shaped or globular and 2 to 3 mm. wide. At Naples, Italy, the medusa appears to be quite invariable, and according to Hartlaub, 1887, the manubrium is spindle-shaped and five-sided with 5 perradial oral tentacles and 5 perradial sac-like outgrowths upon the sides of the stomach. Thus in the Naples medusæ 5 main radial-canals, 72° apart, arise from the stomach, but 3 of these bifurcate so that 8 canals, 45° apart, join the circular vessel at the margin. These 5 main radial-canals are arranged as follows: 2 bifurcated canals 72° apart; 2 simple, unbranched canals 144° apart; 1 bifurcated radial-canal midway between the two simple canals, i. e., 72° from each. Thus in glancing around the margin in the direction of the order of succession of the hour-numbers on the dial of a clock, we may begin with a simple canal, then comes a bifurcated, then a simple, next a bifurcated, and finally another bifurcated canal. 2 of the bifurcated canals are thus side by side and the 2 simple canals are separated one from another by an interval occupied by the third bifurcated canal.

There are 8 tentacles upon the Naples medusæ, one at the end of each terminal radial-canal. The basal bulbs of these tentacles are heavy and swollen, and each bears an abaxial ocellus. 1 to 3 sucker-bearing filaments arise from the inner sides of the tentacles and their outer parts terminate in 4 to 6 branches which are armed with nettling warts and end in knobs.

The gonad encircles the stomach and is not confined to the sac-like protrusions, as was believed to be the case by Haeckel. According to Hartlaub, the genital products originate in the entoderm, but when mature are found in the ectoderm of the manubrium; yet according to Weismann they originate and remain in the ectoderm.

The medusa exhibits a successive hermaphroditism, according to Hartlaub, although either sex may precede in the process. (See also Müller, 1908.)

The stomach, ring-canal, and tentacles are red to brown.

This medusa is abundant off the Atlantic coasts of England, Holland, and France, and in the Mediterranean. Haeckel records a number of departures from the normal form. These are probably only aberrations, but he gives specific names to each and every one of them. For example, the oral tentacles and the sac-like outgrowths on the stomach may range from 4 to 5; and there may be 10 simple, or 4 bifurcated radial-canals.

There appear indeed to be many local races of this medusa, and I am inclined to believe that *Cladonema perkinsii* and *C. mayeri* of America may prove to be only varieties of *C. radiatum*.

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Billard has studied the variations of the medusa at the Bay de la Hougue near St. Vaast on the northwestern coast of France. Here he found that among 50 medusæ 5 had 6 radial-canals, 4 had 7, 39 had 8, 1 had 9, 0 had 10, 1 had 11. In the case of the 39 medusæ with 8 radial-canals, 36 had 2 simple and 3 bifurcated canals, as in the Naples medusa.

Müller, 1908, has studied the origin and structure of the ova in this medusa. The eggs are small and rounded and widely scattered in the gonad, for the successful eggs devour the weaker in the ovary. The ooplasma is sparsely vacuolated and there is very little yolk.

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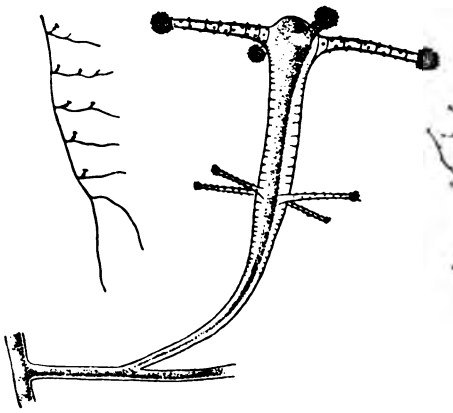

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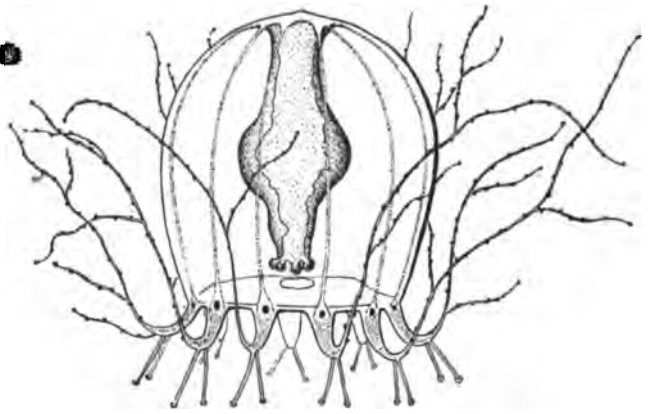

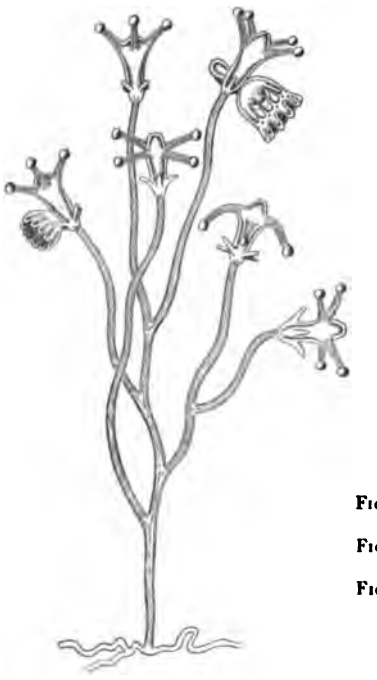

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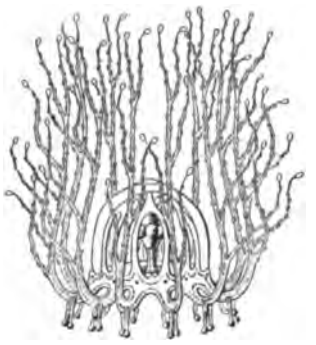

FIG. 53.—Hydroid of *Cladonema radiatum*, after Hincks, in British Hydroid Zoophytes. Showing growth-habit of hydroid and enlarged view of single polypite.
FIG. 54.—*Cladonema radiatum*, after Allman, in Ray Society, 1871–72. Budding hydroid and mature me lusa.
FIG. 55.—Medusa of *Cladonema radiatum*, after Hincks, in British Hydroid Zoophytes.

The hydroid of *Cladonema radiatum* is *Stauridia radiatum* Dujardin = *Cladonema radiatum* Hincks.

The hydrorhiza is a slender, creeping filament from which the hydranths arise at intervals. These hydranths are either simple, unbranched, and about 2.5 mm. high, or are borne upon slightly branching stems 12 to 25 mm. high. The hydranths are club-shaped and have 2 alternating verticils, each circlet consisting of 4 tentacles. The circlet near the mouth is composed of long tentacles, each of which ends in a knob, while the circlet at the base of the hydranth consists of 4 very short, simple, unbranched, filiform tentacles which alternate with (i. e. are upon meridians 45° apart from) the oral circlet. The medusæ bud out singly from the sides of the polypite at a short distance above the basal circlet of tentacles. The

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body of the hydranth is pale reddish and the perisarc bright yellowish-brown. The medusæ are produced in spring and summer.

Dujardin's, 1843, observations upon *Cladonema radiatum* are the earliest in which the complete life-history of the alternation of generations between hydroid and medusa was actually observed.

### Cladonema perkinsii Mayer.

Plate 9, fig. 1.

*Cladonema, sp.*, PERKINS, 1902, Johns Hopkins University Circulars, vol. 21, No. 155, p. 25, figs. in text.
*Cladonema perkinsii*, MAYER, 1904, Memoirs Nat. Sci. Brooklyn Inst. Arts and Sci , vol. 1, No. 1, p. 18, plate 4, fig. 35.—HARTLAUB, 1907, Nordisches Plankton, Nr. 12, p. 135, fig. 126.

Bell half-egg-shaped; less than 2 mm. in diameter, with thin, uniform walls. 8 large, stout, marginal tentacles. The inner and lateral parts of each of these tentacles bear 3 to 10 small, flexible cirri, which are besprinkled with wart-like clusters of nematocysts and terminate in a knob. There is a large, cup-like, ectodermal ocellus upon the outer side of each main tentacle shaft near the bell-margin. The velum is large and shows circular striations. Manubrium large and spindle-shaped, with about 6 rounded, protruding pouches at its widest part. The mouth is surrounded by a circlet of 5 simple, short oral tentacles each terminating in a knob-like mass of nematocysts. 8 simple radial-canals, 45° apart, arise from the stomach, and extend straight toward the simple circular vessel. The manubrium is thus 8-sided at its proximal end, 6-sided in the middle, and 5-sided at the mouth. The genital products develop in the ectoderm of a large part of the manubrium and also in the hernia-like pouches. The ocelli are black and all other parts colorless. This species was discovered by Professor Perkins in Nassau Harbor, Bahamas, in July, 1902, upon the surface in shallow water at night.

### Cladonema mayeri Perkins.

Plate 9, figs. 2 and 3.

*Cladonema, sp.*, FEWKES, 1883, Bull. Mus. Comp. Zool. at Harvard College, vol. 11, p. 87.
*Cladonema mayeri*, PERKINS, 1906, Year Book of the Carnegie Institution of Washington, No. 4, 1905, p. 118.—1908, Papers from Tortugas Lab. Carnegie Inst. Washington, vol. 1, p. 136, plates 1 and 2, plate 4, figs. 21, 22. Hydroid and medusa.

Bell thin-walled, higher than a hemisphere, and with small, solid, apical projection; top rounded and dome-like, and total height about 2.5 mm. There are 9 marginal tentacles, one at the foot of each radial-canal. Each of these tentacles has a large, spindle-shaped basal bulb, the entoderm of which contains a mass of white concretions. On the outer side of each basal bulb near the circular canal there is a deep reddish-brown, ectodermal pigment spot. The distal, inner side of each basal bulb gives rise to about 6 small tapering peduncles which terminate in small knob-like adhesive disks. These enable the medusa to cling to the sides or bottom of the aquarium. The main shaft of each tentacle extends outward from the spindle-shaped end of the basal bulb. It is uniform, thread-like, and slender, and gives rise to 4 to 8 thread-like side branches each of which, together with the central shaft, terminates in a knob-like cluster of nematocysts. There are 4 to 6 nematocyst-warts upon each side branch and a greater number upon the main shaft. Both the main shaft and the side branches are highly contractile and can be expanded so as to become longer than the bell-height, or contracted into a close bunch. The velum is very wide and its orifice small. 6 radial-canals arise from the stomach, but every alternate canal bifurcates near its point of origin, and thus 9 equally spaced canals reach the circular vessel. The manubrium normally extends to the level of the velar opening, but may contract somewhat at times, as is shown in our figure. The mouth is surrounded by 6 simple oral tentacles, each of which terminates in a large nematocyst-knob. Near the middle of the stomach there is a circlet of 6 radially arranged, short, blunt, hernia-like projections. The genital products are developed in the ectoderm of the walls of the manubrium.

The color is quite variable. The entoderm of the basal bulbs of the marginal tentacles is milky-yellow streaked with dark-brown pigment-granules, while the entoderm of the manubrium is milky-yellow or dull-milky ocher, streaked longitudinally in each of the 6 radii by dark-brown, almost black, pigment-granules. The disposition and arrangement of this pigment is highly variable. Perkins, 1908, gives the most complete account of this medusa and its hydroid.

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This medusa, together with its hydroid stage, was found in great numbers by Prof. Henry F. Perkins in the salt-water moat of Fort Jefferson, Tortugas, during the summer of 1905. The hydroid is a minute *Stauridia* which grows upon algæ. The same medusa was described by Fewkes, 1883, as being in association with *Cassiopea* at Fleming's Key, near Key West, Florida.

### Genus DENDRONEMA Haeckel, 1879.

*Dendronema*, HAECKEL, 1879, Syst. der Medusen, p. 110.—GÜNTHER, 1903, Mitth. Zool. Sta. Neapel, Bd. 16, p. 57.

The only known form is *Dendronema stylodendron* Haeckel, from the Canary Islands, Atlantic Ocean.

#### GENERIC CHARACTERS.

Cladonemidæ with branched oral tentacles and branched marginal tentacles, the branches ending in nematocyst-knobs or adhesive disks, or both. With bifurcated radial-canals. Gonads in the stomach-wall.

There is an apical cavity above the stomach, but we do not know whether this is a mere extension of the stomach itself, or a reproductive sac similar in anatomy to that of *Eleutheria*.

### Dendronema stylodendron Haeckel.

*Dendronema stylodendron*, HAECKEL, 1879, Syst. der Medusen, p. 110, taf. 7, fig. 8.

Bell miter-shaped, with pointed conical apex. 9 mm. high, 6 mm. wide. Stomach spindle-shaped. There are apparently 4 radially placed oral tentacles each of which branches dichotomously 6 to 7 times and terminates in (50 to 60) nematocyst-knobs in each quadrant. Haeckel's description is, however, vague upon this point. Haeckel states that there are 4 egg-shaped "gonads" on the 4 perradial sides of the stomach. These may, however, be homologous with the protuberances seen in *Cladonema* (?) Haeckel's figure shows them distended with ova. 4 principal radial-canals, 90° apart, leave the stomach and bifurcate so that 8 vessels reach the ring-canal 45° apart. There are 8 marginal tentacles, one at the base of each radial-canal. There is an ectodermal abaxial ocellus at the base of each tentacle. Each tentacle gives off a stout, short branch on its inner (velar) side, and this branch bifurcates twice and terminates in 4 nematocyst-bearing, knob-like "suckers," or adhesive organs. The main shaft of the tentacle also branches dichotomously many times and is besprinkled with nettling warts, and the ends terminate in large knobs. There is a spindle-shaped cavity in the apex of the bell, above the stomach, but its anatomical character is unknown. The mouth, stomach, apical cavity, and gonads are reddish-yellow. Tentacles, radial-canals, and ring-canal brownish-red. Ocelli black.

This medusa was found by Haeckel in the Canary Islands, Atlantic Ocean, in February, 1867.

### Family OCEANIDÆ, sens. Vanhöffen, 1891.

*Oceanidæ* (in part), ESCHSCHOLTZ, 1829, Syst. der Acalephen, p. 96.—FORBES, 1848, British Naked-eyed Medusæ, p. 21.—GEGENBAUR, 1856, Zeit. für wissen. Zool., Bd. 8, p. 219.
*Tiaridæ + Margelidæ + Cannotidæ* (in part), HAECKEL, 1879, Syst. der Medusen, pp. 40, 68, 156–159.
*Oceanidæ*, VANHÖFFEN, 1891, Zool. Anzeiger, Bd. 14, p. 443.

#### FAMILY CHARACTERS.

Anthomedusæ with 4, or 4 pairs of, isolated gonads upon the interradial or adradial sides of the stomach. The marginal tentacles may arise singly or in clusters, but are neither branched nor feathered.

The Oceanidæ constitute the third family of the Anthomedusæ, and they are more complex and more highly differentiated than the simple and more primitive Codonidæ.

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We distinguish three subfamilies of Oceanidæ.

1. *Tiarinæ*. Lips without oral tentacles. Simple unbranched radial-canals. Tentacles arise separately from the bell-margin and are not grouped in clusters.
2. *Margelinæ*. With oral tentacles. Simple, unbranched radial-canals. In some genera the marginal tentacles arise singly; in others they are grouped in clusters.
3. *Dendrostaurinæ*. Lips without oral tentacles. The radial-canals branch.

Direct development of the medusa from the egg is unknown in this family. The following genera are known to develop through Tubularian hydroids: *Stomotoca*, *Turris*, *Podocoryne*, *Stylactis*, *Bougainvillia*, *Nemopsis*, *Lizzia*, and *Willia*.

Medusæ are produced asexually upon the interradial sides of the manubrium in *Cytæis*, *Podocoryne*, *Bougainvillia*, and *Rathkea*. In some species of *Bougainvillia* the eggs undergo part of their development within the ectoderm of the parent medusa, and are discharged as well-developed planulæ. In *Niobia* the tentacle-bulbs develop into new medusæ, and are set free one after another to repeat this process. In *Willia* and *Proboscidactyla*, medusa-buds are produced upon hollow stolons which may arise from the corners of the stomach at the points of juncture with the radial-canals, or from the places where the canals fork, as in *P. flavicirrata*, var. *stolonifera*, Maas.

Haeckel, 1879, describes the gonads of the Oceanidæ as being perradial in position and on the sides of the stomach in the same sectors with the radial-canals, but Vanhöffen, 1891 (Zool. Anzeiger, Bd. 14), showed that this is an error, for the gonads are almost universally adradial or interradial in position and alternate with the sectors of the radial-canals.

The specialized conditions displayed by the medusæ of the Oceanidæ, such as the corrugated, folded gonads of the Tiarinæ, the clustered marginal tentacles and the oral tentacles of the Margelinæ, and the forked radial-canals and other peculiar structures in the Dendrostaurinæ, all indicate that the Oceanidæ are derived from simpler forms, such as the Codonidæ. Indeed, the conditions seen in the Oceanidæ are largely foreshadowed in the more differentiated Codonidæ and in the Cladonemidæ. In common with the Codonidæ and Cladonemidæ the Oceanidæ are derived from Tubularian hydroids.

### Subfamily TIARINÆ Haeckel, 1879.

*Oceanidæ* (in part), Eschscholtz, 1829, Syst. der Acalephen, p. 96.—Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, p. 219.
*Nucleiferæ* (in part), Lesson, 1843, Hist. Nat. Zooph. Acal., p. 283.
*Tiaridæ*, Haeckel, 1879, Syst. der Medusen, p. 40.
*Sens. restr., Cœlomerinthia*, Vanhöffen, 1891, Zool. Anzeiger, Bd. 14, p. 443.
*Tiaridæ*, Hartlaub, 1892, Nachrichten kgl. Gesell. Wissenschaft. Univ. Göttingen, pp. 19–22; 1907, Nordisches Plankton, Nr. 12, p. 5.
*Sens. restr., Tiaridæ*, Maas, 1904, Résult. Camp. Sci. Prince de Monaco, fasc. 28, p. 11.
*Tiarinæ*, von Lendenfeld, 1884, Zool. Anzeiger, Bd. 7, p. 446.

#### CHARACTERS OF THE TIARINÆ.

Anthomedusæ with 4 lips, without oral tentacles. With 4 or more unbranched radial-canals and with simple, hollow, unbranched tentacles which are not grouped in clusters, but arise separately from the bell-margin. With interradial or adradial gonads forming swollen, corrugated regions in the walls of the stomach.

The following table shows the genera of the Tiarinæ.

1. Tribe Protiaridi:
   The outer surfaces of the four interradial gonads are smooth. Not corrugated or folded. There are 4 simple lips, 4 radial-canals, and a ring-canal, 4 or more tentacles.
   *Protiara* Haeckel, 1879. With 4 radial-canals and 4 radially situated marginal tentacles. 4 simple lips not complexly folded. Hydroid unknown.
   *Heterotiara* Maas, 1905. With 4 radial-canals, and 8 marginal tentacles. Ring-canal gives rise to interradial, blindly-ending, centripetal canals. Only species is *H. anonyma*, Maas, 1905, Craspedoten Medusen *Siboga* Expedition, Monog. 10, p. 19, taf. 3, figs. 19–21, Malay Archipelago. Hydroid unknown.
2. Tribe Amphinemidi:
   With 2 long and numerous rudimentary tentacles. There are 4 radial-canals.
   *Stomotoca* L. Agassiz, 1862 = *Amphinema* + *Stomotoca* + *Codonorchis*, Haeckel, 1879. With two well-developed tentacles. Manubrium may or may not be mounted upon a peduncle. Gonads corrugated, folded, swollen regions upon interradial or adradial sides of stomach.
   *Dissonema* Haeckel, 1879. With 2 well-developed and numerous rudimentary tentacles. During their development gonads migrate outward from sides of stomach down the 4 radial-canals.

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3. Tribe PANDÆIDI:
With 4 or more well-developed tentacles. The gonads are interradial, corrugated, or folded ridges in the wall of the stomach 4 radial-canals.
*Pandea* LESSON, 1843 (1837?). 4 interradial gonads in stomach-wall, not completely separated in the 4 principal radii. Hydroid unknown.
*Conis* BRANDT, 1838. Ocelli borne upon ends of special, short clubs which arise from bases of tentacles. Hydroid unknown.
*Turris* LESSON, 1843 = *Tiara*, LESSON + *Catablema*, HAECKEL. With 4 interradial crescent-shaped gonads in the ectoderm of the stomach-wall. Each crescent is composed of partially fused, swollen ridges. Hydroid: *Clavula* (?), *Campaniclava* ? or *Perigonimus* (?)

4. Tribe CALYCOPSIDI:
With more than 4 simple, unbranched radial-canals. Adradial, transversely folded gonads.
*Calycopsis* FEWKES, 1882. With 16 simple, separate, unbranched radial-canals, 4 radial, 4 interradial, 8 adradial.

Haeckel, 1879, established the family Tiaridæ for Anthomedusæ with 4 wide, crenulated lips; with 4 separated or 8 cleft gonads in the stomach-wall; with 4 wide, band-like radial-canals; and with simple, unbranched tentacles.

Vanhöffen, 1891, showed that the gonads were interradial, not radial in position as was supposed to be the case by Haeckel; and in 1892 Hartlaub gave important details of the structure of the gonads, showing that *Pandea* had simpler gonads than either *Tiara* or *Turris*. For example, he showed that the gonads of *Pandea conica* consist of 4 interradial, horseshoe-shaped, network-like, swollen regions in the ectoderm of the stomach-wall. The gonads of *Turris cæca*, however, consist not only in the interradial network, but chiefly in a double row of fused longitudinal swellings in each interradial quadrant of the stomach. In *Tiara pileata*, on the other hand, we find none of these network-like gonads, but instead a horseshoe-shaped gonad in each interradial quadrant, the apex being upward and the sides of the horseshoe being made up of a series of laterally-fused, horizontal swellings. Maas, 1904, *loc. cit.*, gives clear figures of these conditions and supports Hartlaub's observations.

In the more complex and specialized Tiarinæ, represented by the tribes Amphinemidi and Pandæidi, the gonads are thrown into complex folds or corrugations, and the lips have become recurved, with folded edges.

Vanhöffen concluded that *Amphinema* and *Codonorchis* of Haeckel are equivalent to *Stomotoca* L. Agassiz; and in this I concur. He also maintained that *Pandea* Lesson was identical with *Tiara* Lesson, but in 1892 Hartlaub showed that the gonads of *Pandea* were quite different in structure from those of *Tiara*; and Maas, 1904, supports this conclusion.

Maas, 1904, calls attention to the fact that there are no definite distinctions between *Turris* and *Tiara*. He shows that the gonads of *Turris* consist of 4 interradial horseshoes, the sides of each horseshoe being made up of partially fused, transverse, branched, ectodermal ridges and the upper apex of the horseshoe being composed of an open network of ridges. In *Tiara* the gonads are horseshoe-shaped, but commonly lack the network-like ridges. The transverse ridges do anastomose to some degree, however, in *Tiara*, so that a partial network is often found. See Maas, 1904, *loc. cit.*, plate 2, fig. 11.

Maas describes the gonads of *Catablema* Haeckel as horseshoe-shaped and composed of partially fused, vertical ridges. In the fully-grown medusa, however, I find that the ridges tend to become transverse, as in *Turris* or *Tiara*.

Maas, 1904, retains the genus *Catablema* of Haeckel to include medusæ resembling *Turris* or *Tiara*, but with blindly-ending, lateral diverticula upon their radial-canal and ring-canal. As a matter of fact these diverticula are highly variable in different individuals of the same species and are seen in a more or less well-developed condition in the majority of Tiarinæ. I therefore believe that confusion will be avoided if we combine the genera *Turris*, *Tiara*, and *Catablema* to form a single genus. This should be called "*Turris*," for Lesson used this name on page 283 of his Hist. Zooph. Acal., and on page 17 of his "Prodrome," 1837. *Tiara* he defines later on page 286 of his "Histoire," 1843, and on page 20 of his "Prodrome," 1837.

I propose, therefore, following the lead of Vanhöffen, Hartlaub, and Maas, to reduce the 13 genera of Tiarinæ enumerated by Haeckel, 1879, to 8, as follows: *Stomotoca*, *Modeeria*, *Protiara*, *Heterotiara*, *Pandea*, *Turris*, *Conis*, and *Calycopsis*.

The Tiarinæ are widely distributed, but are abundant only along continental coasts, for in so far as is known, they arise by budding from Tubularian hydroids of the genera *Perigonimus*, *Clavula* (?), and *Campaniclava* (?). Asexual budding or direct development in the medusa-stage is unknown.

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The medusæ of the various genera of Tiarinæ bear a close resemblance one to another. Their bells are usually miter-shaped; ectodermal ocelli are often found upon their hollow tentacle-bulbs, and their radial-canals are usually broad and flat, and often with more or less jagged outlines.

All of the tentacles arise from the lower edge of the bell-margin when young, but as growth proceeds, the upper parts of the basal bulbs of the older ones are crowded and forced a short distance up the sides of the bell, while the smaller tentacles still remain upon the lower edge of the bell-margin. This gives the appearance of two rows of tentacles.

Hartlaub demonstrated that the so-called mesenteries of Haeckel, 1879, are only the wide, funnel-like origins of the radial-canals, where they communicate with the stomach-cavity.

As Maas, 1904, has shown, the Tiarinæ have given rise to the more specialized Bythotiaridi, wherein the radial-canals have become branched, and the latter are probably related to the Williadi. The Tiarinæ are themselves derived, probably, from Codonidæ in which the originally ring-like gonad has become radially separated, so that it lies only in interradial positions on the wall of the stomach. They are thus, apparently, more highly specialized than the Codonidæ. *Calycopsis* with its 16 simple, unbranched radial-canals may be regarded as a form intermediate between the Tiarinæ and Bythotiaridi.

The Tiarinæ are distinguished from the Margelinæ by the fact that oral tentacles are never found in the Tiarinæ, but are present in the Margelinæ. Moreover, the tentacles of the Tiarinæ arise singly from the bell-margin, and are not grouped in clusters as is frequently the case in the more specialized Margelinæ. It seems not improbable that the Tiarinæ and Margelinæ have arisen independently of each other from the Codonidæ. A decided difference between the Tiarinæ and Margelinæ is that in the former the entodermal cores of the tentacles are hollow, and in the Margelinæ they are nearly, if not wholly, solid. When present the ectodermal ocelli in the Tiarinæ are on the *outer* sides of the tentacle-bulbs, whereas in the Margelinæ they are on the *inner* (velar) sides.

### Genus PROTIARA Haeckel, 1879.

*Carminrothe beroe*, SLABBER, 1775, Physikal. Belust., p. 64.
*Protiara*, HAECKEL, 1879, Syst. der Medusen, p. 46.—HARGITT, 1902, Biological Bulletin, Boston, vol. 4, p. 17; 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 34.—LINKO, 1902, Zool. Anzeiger, Jahrg. 25, p. 162.
(?) *Plotocnide*, WAGNER, 1885, Wirbellosen des Weissen Meeres, Bd. 1, p. 74.
*Halitiara*, FEWKES, 1882, Bull. Museum Comp. Zool. at Harvard College, vol. 9, p. 276.—AGASSIZ and MAYER, 1899, Bull. Museum Comp. Zool. at Harvard College, vol. 32, p. 160.

#### GENERIC CHARACTERS.

Tiarinæ with 4 well-developed, radially situated tentacles with hollow, basal bulbs. With 4 longitudinal, swollen gonads on the 4 interradial sides of the stomach. The outer surfaces of these gonads are smooth, not folded, nor corrugated. The 4 lips are simple, not folded nor crenulated.

Haeckel, 1879, founded this genus for *P. tetranema*, which had been previously described by Slabber, 1775, under the name *Carminrothe beroe* from the North Sea and English Channel. According to Vanhöffen, 1891 (Zool. Anzeiger, Bd. 14, p. 441), this medusa is only a young *Corynitis*. However this may be, Hargitt, 1902, discovered a medusa in Vineyard Sound, Massachusetts, which accords well with Haeckel's definition of *Protiara*. The gonads are described by Hargitt as being found in four separate, longitudinal, swollen regions in the interradial (radial?) sides of the stomach. Hargitt cut no sections of the medusa, and consequently we must merely place this species provisionally in the genus *Protiara*, for if the gonads be developed so as to completely surround the stomach and are not separated radially, the medusa is one of the Codonidæ. If it be one of the Tiarinæ, it appears to constitute an interesting intermediate form between some Corynitis like member of the family Codonidæ and the Tiarinæ. It has the simple mouth, narrow canals, and smoothly rounded external surfaces of the manubrium characteristic of the Codonidæ, but its 4 separated, interradial gonads, and its hollow, tapering tentacles ally it to the Tiarinæ.

Linko, 1902, sectioned a somewhat similar medusa from the Murman coast, between Russia and Norway, and demonstrated that the 4 gonads are interradial.

The medusa described by Fewkes as *Halitiara formosa* is evidently a *Protiara*.

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### Protiara beroe.

*Carminrothe beroe*, SLABBER, 1775, Physikalische Belustingungen, Nürnberg, p. 64, taf. 14, fig. 1.
*Oceania tetranema*, PÉRON ET LESUEUR, 1809, Ann. du Mus. Hist. Nat., tome 14, p. 347. Paris.
*Protiara tetranema*, HAECKEL, 1879, Syst. der Medusen, p. 47.
(?) *Protiara*, LINKO, 1902, Zool. Anzeiger, Bd. 25, p. 162, 2 figs.
(?) *Protiara borealis*=*Plotocnide borealis*, Colorless variety, WAGNER, 1885, Wirbellosen des Weissen Meeres, Bd. 1, p. 74, taf. 4, fign. 1, 2.
(?) (*Syndiction*?) *incertum*, LINKO, 1900, Travaux Soc. Imp. Nat. de St. Pétersbourg, tome 29, p. 151, fig. 1 (this is possibly *Sarsia flammea*?).
(?)*Plotocnide incerta*, HARTLAUB, Nordisches Plankton, Nr. 12, p. 70, fig. 66.

Bell 6 to 15 mm. high, 4 to 12 mm. wide. Egg-shaped, with very thick walls, which in the upper part of the bell are one-third to one-fourth as thick as the bell-height. There are a few scattered nettle-cells over the exumbrella, these being more numerous in young than in old specimens. 4 tentacles, each 4 to 5 times as long as the bell-height, with thick basal bulbs about one-sixth as wide as the greatest width of the bell. No ocelli. The shafts of the tentacles bear garland-like pads of nettle-cells. There are 4 straight, narrow radial-canals with smooth edges. The manubrium is short and even in mature medusæ does not project beyond the velar opening. In young medusæ it is conical, in mature individuals very wide, but it narrows greatly at the neck immediately above the mouth. The neck is tubular, and the mouth is encircled with nematocysts. There are 4 longitudinal, interradial, ectodermal gonads, which project widely outward in the upper portion of the manubrium, but do not extend to the mouth. The outer surfaces of the gonads are smooth.

Linko, 1902, sectioned the manubrium and found that the entoderm forms 4 interradial partial septa which project inward in 4 longitudinal folds toward the axial center of the stomach, but their inner edges do not fuse. The cells of these septa are digestive and they serve apparently to increase the area of the stomach-wall. The bell is colorless. Manubrium and tentacle-bulbs orange to yellow, radial-canals white.

Common in Barents Sea, North of Russia, between 68° 54′ and 70° 5′ N. lat.; and 33° 30′ to 57° 38′ long. E. from Greenwich. Rare in harbors and fjords.

(*Syndiction*?) *incertum*, Linko, 1900, may possibly be identical with *P. beroe*. It has a bell 3 mm. high and somewhat more than 3 mm. wide. The walls are thick and there is a rounded, dome-like apex sharply set off from the bell itself. The exumbrella is besprinkled with quite regularly and widely spaced nematocysts. There are 4 thick, tapering tentacles about one-third to one-half as long as the bell-height. These have large, spherical, non-ocellated, basal bulbs. Velum well-developed. 4 straight, slender radial-canals. Stomach mounted upon a short, conical peduncle. The mouth does not reach the level of the velar opening. Mouth-opening round, without prominent lips. The gonad is figured as being much swollen above, tapering below, and encircling the stomach. It is not wholly clear from Linko's description whether there are 4 interradial gonads or only one encircling gonad, for he states that the medusa resembles *P. borealis*=(*Syndiction boreale* Birula) in some of its characters. Only about 10 very large eggs are produced by the female.

The manubrium is yellow to orange, tentacle-bulbs red, and tentacles yellow. Other parts are colorless. Found in the White Sea, Northern Russia. It is probable that this form is a *Sarsia*, and is possibly *S. flammea*. See Hartlaub, 1903, 1907. There is, however, no peduncle in *S. flammea*.

### Protiara borealis.

*Plotocnide borealis*, WAGNER, 1885, Wirbellosen des Weissen Meeres, Bd. 1, p. 74, taf. 4, fign. 1, 2.
*Syndictyon boreale*, BIRULA, 1896, Annuaire Musée Zool. Acad. Imp. Soc. St. Pétersbourg, tome 1, p. 336 (Russian).
(?) *Protiara hæckelii*, HARGITT, 1902, Biological Bulletin, vol. 4, p. 16, fig. 4; 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 34, 1 fig.
*Plotocnide borealis*, HARTLAUB, 1907, Nordisches Plankton, Nr. 12, p. 69, fig. 65.

Bell is about 3 mm. high and 1.5 mm. wide, with simple rounded apex and thick walls. 4 radially situated tentacles, each about as long as the bell-height. These tentacles are besprinkled with nematocysts and have well-developed, conical, basal bulbs, without ocelli. Wagner's specimens were apparently much younger than Hargitt's and each tentacle terminated in a large knob-like cluster of nematocysts. In Hargitt's specimen the tentacles taper gradually to their tips. The velum is well-developed. There are 4 straight, narrow radial-

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canals, and a simple ring-canal. The manubrium is mounted upon a short, conical peduncle and is quite wide; rectangular above, but nearly circular in cross-section near the mouth. There are 4 very small, simple lips. In Wagner's specimens the manubrium was only about half as long as the depth of the bell-cavity, whereas in Hargitt's the mouth extended nearly to the level of the velar opening. This difference may be due to age (?) The gonads are 4 large, interradial, longitudinal swellings on the sides of the stomach. The outer surfaces of the gonads are smooth.

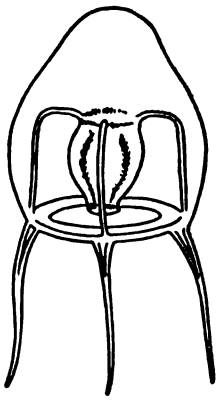

FIG. 56.—*Protiara "haeckeli,"* after Hargitt, in Biological Bulletin.

Wagner found a few specimens of this medusa in April, in the White Sea, north coast of Russia. Hargitt found an apparently identical medusa in summer near No Man's Land, an island off the southern coast of Massachusetts. The gonads and tentacle-bulbs in Hargitt's medusa are milky in color, other parts being transparent.

This species is distinguished from *Protiara beroe* (=*P. "tetranema"* Haeckel) by its absence of color and lack of ocelli.

Unfortunately no sections have been made of the manubrium. Wagner's figure and description are unsatisfactory in that he leaves the position of the gonads in uncertainty and we can not tell whether there are 4 (interradial ?) gonads or only 1 encircling gonad.

### Protiara formosa.

Plate 6, figs. 4, 5, and 6; plate 13, figs. 1 and 2.

*Halitiara formosa*, FEWKES, 1882, Bull. Mus. Comp. Zool. at Harvard Coll., vol. 9, p. 276, plate 4, fig. 2.—MAYER, 1904, Memoirs Nat. Sci. Mus. Brooklyn Inst. Arts and Sci., vol. 1, No. 1, p. 8, plate 1, fig. 8.—AGASSIZ, A., AND MAYER, 1899, Bull. Mus. Comp. Zool. at Harvard Coll., vol. 32, p. 160.—MAYER, 1900, Bull. Mus. Comp. Zool. at Harvard Coll., vol. 37, p. 31.

Bell about 3 mm. high and pear-shaped with solid apical projection. There are 4 long, tapering, radially situated tentacles, about two-thirds as long as the bell-height. These tentacles are hollow, with long, tapering, basal bulbs, and their ends are usually coiled in a close helix. In addition to these 4 long tentacles there are 24 to 35 short, solid tentacles, not one-fourth as long as the large ones. These short tentacles are tightly coiled, their axial cells are chordate and they are more like cirri than tentacles. There are no ocelli or other marginal bodies. The velum is narrow. There are 4 straight, narrow radial-canals and a slender circular vessel. The manubrium is pyriform to conical and about half as long as the depth of the bell-cavity. The mouth is a simple, cruciform opening. The gonads are developed in the ectoderm on the interradial sides of the manubrium and the ova are large and conspicuous. The entoderm of the manubrium and tentacle-bulbs in the female (plate 6, fig. 5) is green, but in the males light-brown (plate 6, fig. 4).

This medusa is very abundant at Tortugas, Florida, but is not so common in the Bahamas. An apparently similar form was found by Agassiz and Mayer in the Fiji Islands, South Pacific, although the Pacific form was duller in color than is usual in Atlantic specimens.

## Genus HETEROTIARA Maas, 1905.

*Heterotiara*, MAAS, 1905, Craspedoten Medusen der *Siboga* Exped., Monog. 10, p. 19.

The type species is *Heterotiara anonyma* Maas, from the Malay Archipelago. Only two imperfect specimens were found by the *Siboga* Expedition.

### GENERIC CHARACTERS.

Tiarinæ with 8 marginal tentacles (4 radial, 4 interradial). The ring-canal gives rise to one (or more ?) blindly-ending, centripetal diverticula. Gonads ( ?)

### Heterotiara anonyma Maas.

*Heterotiara anonyma*, MAAS, 1905, Craspedoten Medusen der *Siboga* Exped., Monog. 10, p. 19, taf. 3, figs. 19–21.

Bell 12 to 16 mm. high and slightly more than half as wide. Oval, dome-like, with very thick, gelatinous walls. 8 hollow marginal tentacles arise from the ring-canal and extend through the gelatinous sides of the bell so as to reach the exterior at a slight distance above the margin. The basal bulbs of these tentacles are small, and each one has a short, blunt, hollow,

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spur-like projection extending outward. There are no ocelli. All of the tentacles were broken off short and their normal length is thus unknown.

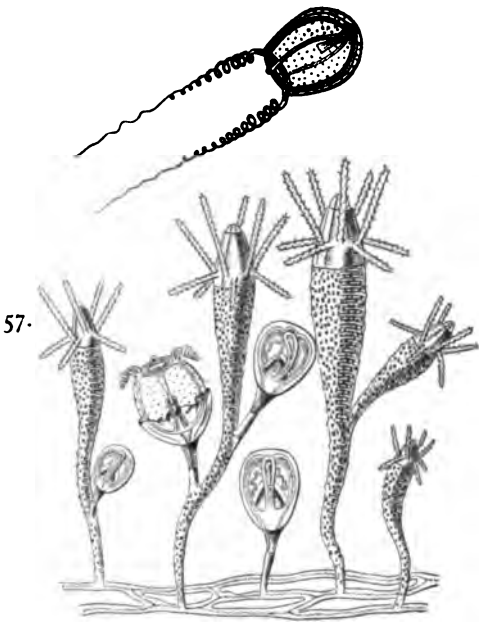
The ring-canal gives off a short, straight, blindly-ending diverticulum in one of the 4 interradii above the base of one of the interradial tentacles. 4 wide radial-canals as in other Tiarinæ. They are straight-edged and lack the "glandular-pouches" seen in many Tiarinæ.

The circular muscles of the subumbrella are very easily seen near the edges of the radial-canals and there are 4 interradial folds in the muscles which present the superficial appearance of radial-canals, but they are merely radial muscle furrows, in no way to be confused with the radial-canals.

The manubrium lacks a peduncle and is about half as long as the depth of the bell-cavity. It is 4-sided at its base. The stomach part is urn-shaped, and there are 4 folded lips. Gonads (?) The tentacle-bulbs bear dense entodermal pigment granules. Color (?)

Two specimens were found by the *Siboga* expedition in the Malay Archipelago in vertical nets drawn from 500 fathoms depth to the surface, in lat. 0° 17.6′ S., long. 129° 14.5′ E.

It is remarkable that in each of these specimens there was but one interradial diverticulum from the ring-canal. 4 interradial swellings are figured by Maas upon the sides of the stomach, but he does not mention gonads. Apparently both of his specimens were immature.



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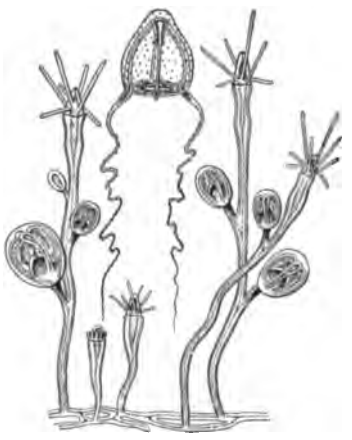

58.

FIG. 57.—"*Perigonimus vestutus*." Hydroid and recently liberated medusa.
FIG. 58.—"*Perigonimus minutus*." Hydroid and young medusa.
Above figures after Allman, in Ray Society, 1871–72.

### Genus STOMOTOCA L. Agassiz, 1862.

(?) *Gladde beroe*, SLABBER, 1775, Physikal. Belustig., p. 46.
*Saphenia*, FORBES (*non* Eschscholtz), 1848, British Naked-eyed Medusæ, p. 25, plate 2, fig. 4.—McCRADY, 1857, Gymn. Charleston Harbor, p. 27.
*Stomotoca*, AGASSIZ, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 347.—A. AGASSIZ in L. AGASSIZ's, 1862, Cont. Nat. Hist. U. S., vol. 4, p. 347 (foot-note).—AGASSIZ, A., 1865, North Amer. Acal., p. 168.
*Dinema*, VAN BENEDEN, 1867, Mem. Acad. Roy. des Sci. Belgique, tom. 36, par. 2, p. 127.
*Amphinema+Stomotoca*, HAECKEL, 1879, Syst. der Medusen, pp. 49, 51.
*Codonorchis*, HAECKEL, 1879, *Ibid.*, p. 51.
*Dinematella*, FEWKES, 1881, Bull. Mus. Comp. Zool. at Harvard College, vol. 8, p. 151.
*Stomotoca*, VANHÖFFEN, 1891, Zool. Anzeiger, p. 443.—MAAS, 1897, Mem. Mus. Comp. Zool. at Harvard College, vol. 23, No. 1, p. 11.

This genus was founded by L. Agassiz, 1862; the oldest species is possibly *Stomotoca slabberi* of the northern coasts of Europe. This species was first described by Slabber, 1775, under the name of *Gladde beroe*, and the hydroid and young medusa were described by Van Beneden, 1867, as *Dinema slabberi*. Slabber's description is, however, so unsatisfactory that we can not be certain that this medusa is actually a *Stomotoca*, and can not accept it as the type of the genus. *Stomotoca dinema* (*Oceania dinema*) Péron and Lesueur may be taken as the type of the genus. The genus *Saphenia* Eschscholtz belongs to the Eucopidæ.

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PLATE 10.

Fig. 1. *Dissonema turrida.* Tortugas, Florida, May 13, 1905. An abnormal specimen lacking ocelli and marginal cirri.

Fig. 2. *Stomotoca dinema*, female. Agassiz Laboratory, Newport, Rhode Island, July, 1892.

Fig. 3. *Stomotoca dinema*, male. Agassiz Laboratory, Newport, Rhode Island, September 13, 1896.

Fig. 4. *Stomotoca dinema*, male. Agassiz Laboratory, Newport, Rhode Island, July, 1896.

Figs. 5 and 6. *Stomotoca rugosa.* Agassiz Laboratory, Newport, Rhode Island, August 2 to 16, 1892.

Drawn from life, by the author.

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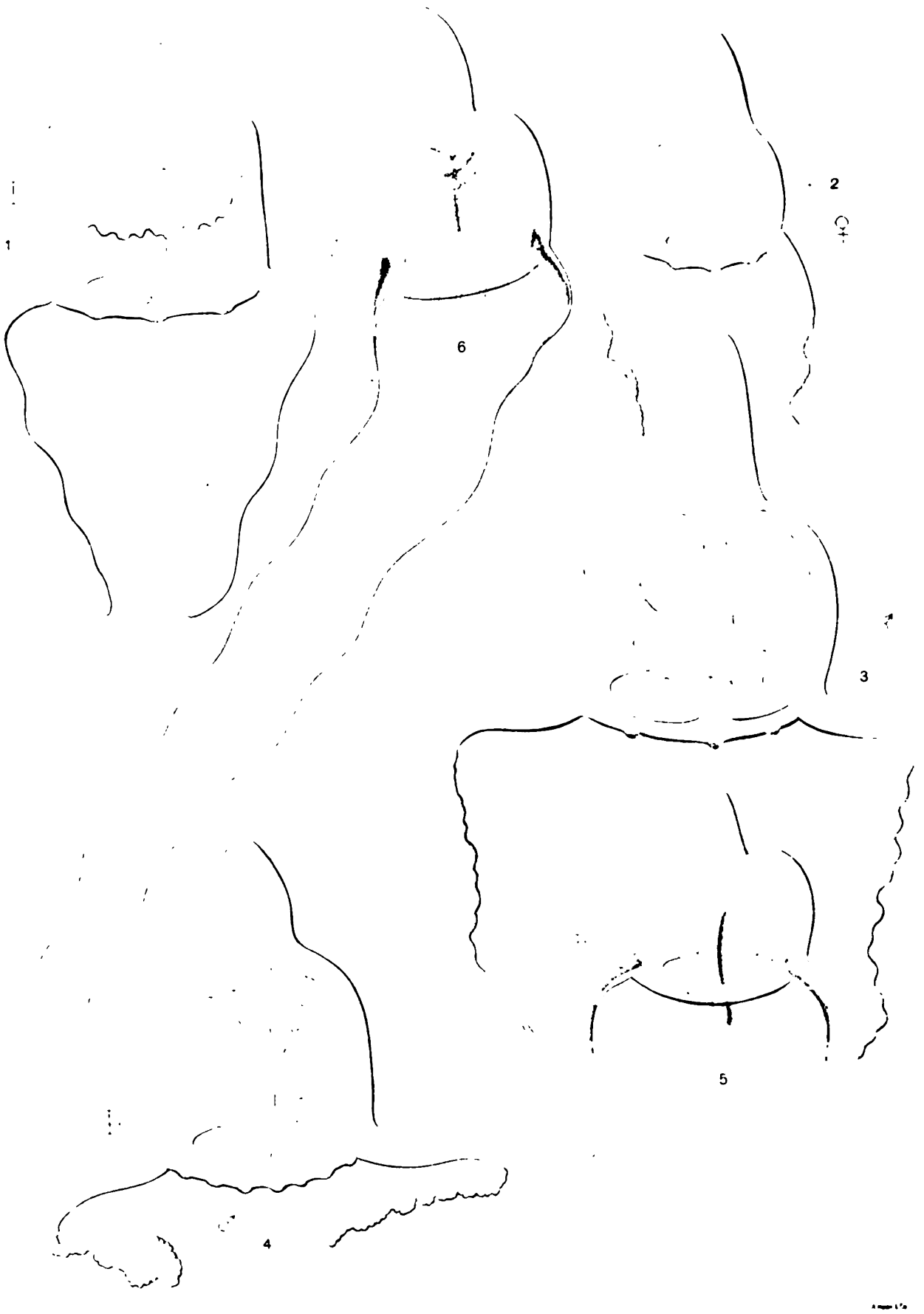


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## Plate 11.

Figs. 1 and 2. *Stomotoca rugosa*, young and mature. Newport, Rhode Island, August 4, 1892.

Fig. 3. Young medusa of *Perigonimus jonesii*. Agassiz Laboratory, Newport, Rhode Island, August 22, 1896.

Fig. 4. Young medusa of *Perigonimus jonesii*. Agassiz Laboratory, Newport, Rhode Island, July, 1896.

Fig. 5. *Stomotoca octaedra*, young medusa. Tortugas, Florida, July 17, 1898.

Fig. 6. *Stomotoca octaedra*, Tortugas, Florida, June, 1897.

Fig. 7. *Pandea violacea*. Aboral view of gonads of the medusa shown in figure 1, plate 12.

Drawn from life, by the author.

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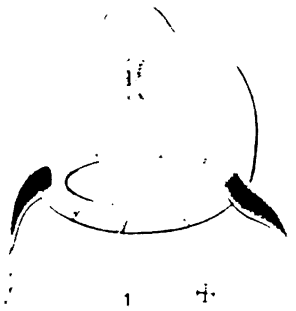
PLATE



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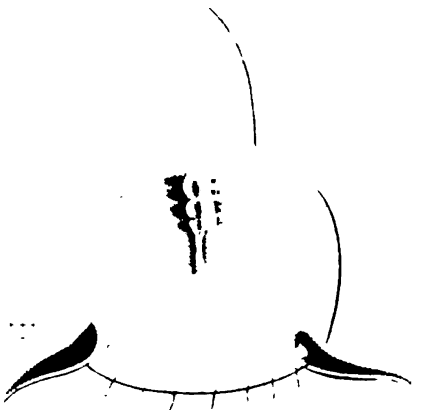

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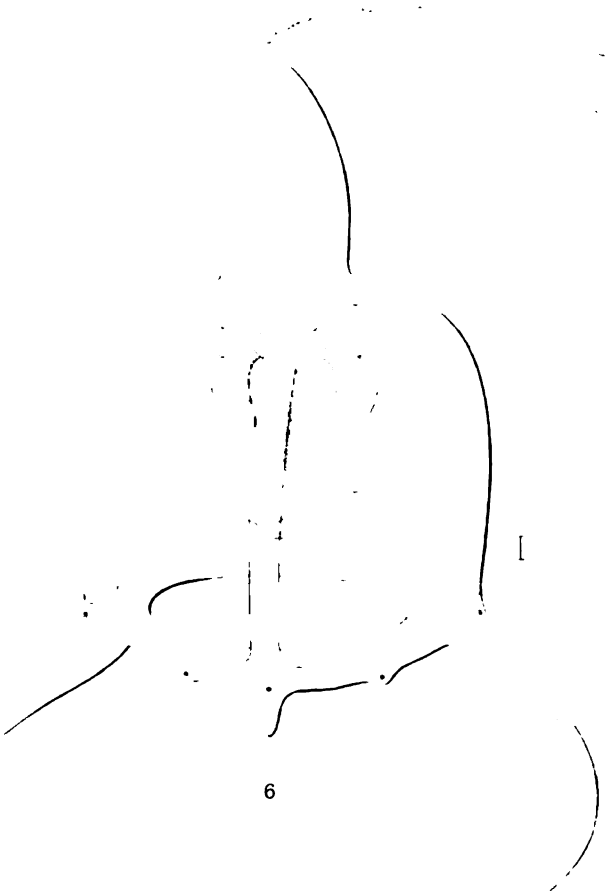

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margin. These lack ocelli. The 4 radial-canals are wide and flat. The boundaries of the radial-canals and of the ring-canal are often bluntly serrated. The manubrium is flask-shaped; there is no peduncle and the 4 lips are cruciform, crenulated, and curve slightly upward. The ectoderm of the upper part of the manubrium on both sides of the 4 radial-canals is thrown into interradial folds or convolutions and the gonads are developed in this region.

In the male the color of the manubrium varies from intense green to translucent ocher-yellow or cream-color. The basal bulbs of the tentacles in the male vary from faint to deep purple. In the female the manubrium is usually translucent ocher-yellow or cream-colored, but occasionally straw-colored or faintly green. The tentacle-bulbs of the female are usually translucent milky or ocher, but occasionally one is found having faintly purple tentacle-bulbs. These sexually dimorphic color peculiarities are seen in the smallest and youngest medusæ as well as in adults. In very young medusæ the apical projection is small or absent. There are 2 tentacles and only 2 rudimentary tentacle-bulbs.

This medusa is common at Newport, Rhode Island, from July 15 to September. It is not common at Tortugas, Florida, and is not seen north of Cape Cod, Massachusetts. On October 28, 1907, I found two male medusæ of this species off Mousehole, Mounts Bay, Cornwall, England.

This species furnishes that which is probably the most remarkable instance of sexual dichromatism to be met with among the hydromedusæ, the color differences affecting parts other than the gonads.

The two males found off the coast of Cornwall, England, were each 2.2 mm. high and similar in all respects to the typical American form; with intense green manubrium and purple tentacle-bulbs, without ocelli. The bell-apex was solid and gelatinous. I believe that *S. apicata* of America is identical with *S. dinema* of Europe. The European medusa may have more rudimentary tentacle-bulbs, but these are very variable in number in the American form.

### Stomotoca atra Agassiz.

*Stomotoca atra*, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 347.—Agassiz, A., 1865, North Amer. Acal., p. 169, figs. 271-273.—Haeckel, 1879, Syst. der Medusen, p. 53.

Bell 20 to 25 mm. high, 20 to 22 mm. wide. Bell-shaped, higher than a hemisphere. 2 long, highly contractile tentacles, and about 80 small rudimentary tentacle-bulbs. Stomach about half as long as the depth of the bell-cavity. Swollen, 4-sided, and mounted upon a peduncle. 4 lips. The gonads are 8 adradial, linear cross-foldings upon the sides of the stomach, each gonad consisting of 12 to 15 folds as in *Turris*. The mouth is dull yellow. Gonads dark-brown to almost black. Tentacles light-brown.

Found by A. Agassiz in great numbers in Port Townsend, Washington, Pacific coast of the United States; from June until September.

### Stomotoca octaedra.

Plate 11, figs. 5 and 6.

*Codonorchis octaedrus*, Haeckel, 1879, Syst. der Medusen, p. 51.
*Stomotoca australis*, Mayer, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 32, plate 1, fig. 2; *Ibid.*, 1904, Mem. Nat. Sci. Brooklyn Inst. Museum, vol. 1, p. 9, plate 1, fig. 9.

The following description is derived from studies of specimens found in the Bahamas, and at Tortugas, Florida.

*Immature medusa* (plate 11, fig. 6).—Bell about 2.5 mm. high and with well-developed, sharp-pointed, apical projection upon aboral side. Bell-walls thin. There are 2 radially situated, diametrically opposed tentacles, each about as long as the bell-height and with long hollow, tapering basal bulbs. There is a single, ectodermal, orange-colored ocellus upon the outer side of each tentacle-bulb near its point of origin from the umbrella. In addition to the 2 long tentacles there are 2 short, rudimentary tentacle-bulbs 90° from the long tentacles. Each of these rudimentary tentacle-bulbs has an ectodermal, orange-colored ocellus upon its outer side, and there are 4 other ocelli upon the bell-margin in interradial positions. There are thus 8 ocelli in all, 4 on the tentacle-bulbs and 4 interradial ones on the bell-margin. The

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velum is well developed. There are 4 straight-edged, wide radial-canals and a broad circular vessel. The manubrium is urn-shaped, quite wide, and with 4 cruciform, recurved lips. The mouth is at a point about half-way between the inner apex of the bell-cavity and the velar opening. The gonads are found in complexly folded regions upon the 4 interradial sides of the stomach. The manubrium and tentacle-bulbs are yellow or greenish-yellow. The entodermal core of the stomach is often orange.

When about 1 mm. high (plate 11, fig. 5) the bell has a small apical projection. There are 2 large tentacles and 2 rudimentary tentacle-bulbs, each with an orange ocellus. There are no other ocelli upon the bell-margin. The manubrium is slender and urn-shaped, without gonads and with 4 simple, cruciform lips.

The young of this medusa are common at Tortugas, Florida, and in the Bahamas throughout the summer. Although the medusa has usually but 2 long tentacles, occasionally one is seen with 4 long, equally developed, radially situated tentacles. The mature medusa has not been seen and we must remain in doubt concerning its generic position, for it may be a young *Turris*. The presence of *ocelli* upon the tentacle-bulbs distinguishes it from all other American species of *Stomotoca* and is a character commonly seen in *Turris*.

I believe this medusa to be identical with Haeckel's "*Codonorchis octaedrus*," which he obtained off the Atlantic coast of France. Haeckel states that this medusa had 2 well-developed tentacles and 10 tentacle-bulbs (2 perradial and 8 adradial). He described the ocelli as brownish-red. Apparently he found but a single specimen and the interradial tentacle-bulbs may have failed to develop. His medusa is described as having folded gonads, and is said to be 4 mm. high and 2.5 wide.

### Stomotoca rugosa Mayer.

Plate 10, figs. 5 and 6; plate 11, figs. 1 and 2.

*Stomotoca apicata*, Fewkes, 1881, Bull. Mus. Comp. Zool. at Harvard College, vol. 8, p. 152, plate 2, figs. 1, 4, 9.—Hargitt, 1901, American Naturalist, vol. 35, p. 581, fig. 40; 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 35, 1 fig. (erroneously labeled *Stomotoca apicata*, female).—Rittenhouse, 1907, Proc. Boston Soc. Nat. Hist., vol. 33, pp. 440, 445, 452, 456 (embryology).

*Stomotoca rugosa*, Mayer, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 4, plate 2, fig. 5; *Ibid.*, p. 32.

*Amphinema apicatum*, Brooks, 1883, Studies Johns Hopkins Biol. Lab., vol. 2, p. 473.

Bell 5 mm. high and 3 mm. broad. Solid, apical projection, in some individuals short and blunt, in others long and slender. Bell-walls of moderate thickness, and bell itself, exclusive of the apical projection, somewhat higher than a hemisphere, with relatively vertical, straight sides. There are 2 long, diametrically opposed tentacles, which are of equal length, and when stretched are fully ten times as long as the bell-height. They are, however, highly contractile and may become not more than one-tenth as long as when fully expanded. The basal bulbs of these long tentacles are large, hollow, and tapering and there are no ocelli.

In addition to the 2 long tentacles there are 14 small, permanently rudimentary tentacles, 2 at the bases of 2 of the radial-canals and 3 in each interradial quadrant. These lack ocelli. The velum is well developed. There are 4 wide radial-canals and a ring-canal, all with jagged edges. The manubrium is quadratic and flask-shaped and the mouth in old medusæ is about at the level of the velar opening. The mouth is cruciform and there are 4 prominent, recurved, crenulated lips. The mature sexual products are found in the ectoderm of the adradial walls of the stomach on both sides of the places of entrance of each of the 4 radial-canals where the surface is thrown into 8 series of complex folds and ridges, a double ridge of folds in each interradius.

The gelatinous substance of the bell is transparent, but the entoderm of the tentacle-bulbs and stomach is brick-red, often streaked with sooty brown. The radial and circular canals are faint red in color. Specimens from Tortugas, Florida, often show black streaks through the brick-red color of the stomach and tentacle-bulbs, and medusæ which have been confined in aquaria for some days often become wholly black in these parts.

*Hydroid and young medusa.*—Professor W. K. Brooks, 1883, describes the hydroid. It is a *Perigonimus*, very much like *P. minutus* Allman, 1871 (Monog. Tubularian Hydroids, p. 324, plate XI, figs. 4–6). It was found at Beaufort, North Carolina, growing upon the lower

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surface of the shells of *Limulus*, fastened to the sand-tubes of *Sabellaria*. The stems are simple and unbranched and are only about 0.2 mm. in height. They are covered for about two-thirds of their length by a delicate, closely-adherent film of perisarc to which foreign particles become attached. The stomach occupies about one-fourth or one-fifth of the length of the stem from which it is separated by a slight constriction. Each polypite has 10 tentacles which point alternately backwards and forwards, those pointing forwards being a little longer than the others. The medusæ are attached by very short peduncles to the sides of the stems. When the medusa is set free it is about 0.5 mm. in height and there is no trace of the apical projection, which develops in about eight days.

In an abnormal individual medusa of this species found at Newport, Rhode Island, in July, 1892, there were 4 long tentacles, 1 at the base of each of the 4 radial-canals. This medusa was maintained alive in an aquarium for more than a month. When first found it had only 2 long tentacles which were diametrically opposite one another at the bases of 2 of the radial-canals. The other 2 tentacles developed later, after the first pair had attained their full length. The medusa had then 4 radially placed tentacles and 12 rudimentary tentacle-buds. This variation is interesting, as it illustrates the close relationship between *Stomotoca* and *Turris*.

*Stomotoca rugosa* is common on the southern coast of New England in summer. It is found all along the coast to southern Florida, but is not very common at Tortugas or among the Bahama Islands. It has never been seen north of Cape Cod, Massachusetts.

Rittenhouse, 1907, finds that the eggs of this medusa are laid between $5^h$ to $5^h$ $30^m$ in the morning. The egg is chalky-white. The entoderm is formed by cellular ingression. The planula settles down upon its side and becomes a branched hydrorhiza from which the polypites bud out.

### Stomotoca pterophylla Haeckel.

Plate 29, figs. 3 to 5; plate 30, fig. 7.

*Stomotoca pterophylla*, HAECKEL, 1879, Syst. der Medusen, p. 52, taf. 4, fig. 10.
*Stomotoca periphylla*, FEWKES, 1889, Report Commiss. Fish and Fisheries for 1886, p. 524.

*Adult medusa.*—Bell conical, with widely flaring sides and small, sharply-pointed apical projection. It is about 20 to 30 mm. in diameter and 10 to 12 mm. in height. The gelatinous substance is very thick at the aboral pole, but becomes thin at the bell-margin. There are 2 long, tapering, marginal tentacles which are situated at the bases of 2 of the radial-canals, 180° apart. When expanded these tentacles are fully 10 times longer than the bell-diameter. In addition to the long tentacles, there are about 60 to 80 small rudimentary tentacle-bulbs, 15 to 20 in each quadrant. The 4 radial-canals are wide, ribbon-like, and flat, with smooth, simple, outer edges. The ring-canal is narrow and its upper edge is smooth. There is a very wide, conical peduncle which extends about to the level of the velar opening. The gastric part of the manubrium is large and swollen and lies mainly outside of the bell-cavity. There are 4 prominent, complexly crenulated, lanceolate lips. The gonads occupy 8 adradially situated, longitudinal swellings upon the sides of the stomach (plate 29, fig. 4). Each gonad consists of a row of swollen, leaf-like ridges which trend in a transverse direction. The stomach and tentacle-bulbs are brown. Radial-canals milky. There are no ectodermal ocelli.

This species is found in the West Indies and the warmer parts of the Gulf Stream. I found many specimens among the Bahamas and at the Tortugas during the spring and early summer of 1907.

It is closely related to *Stomotoca divisa*, described by Maas, from the west coast of Mexico (Mem. Mus. Comp. Zool. at Harvard College, vol. 23, p. 11, taf. 1, figs. 1–19, 1897), but its rich-brown entoderm distinguishes it from the Pacific species.

Haeckel describes this medusa from preserved specimens, and this may account for certain errors in his description and figure. A small apical projection appears to be constantly present and there are no "ocelli." The radial and circular muscles of the velum are very powerfully developed. In extreme states of contraction of the bell the peduncle may extend beyond the velar opening or fall short of reaching it. The long tentacles are highly contractile and when expanded are reduced to mere thread-like filaments.

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### Stomotoca divisa Maas.

*Stomotoca divisa*, MAAS, 1897, Mem. Museum Comp. Zool. at Harvard College, vol. 23, p. 11, taf. 1, fign. 1-9.

Bell 20 to 30 mm. wide, 15 to 20 mm. high. Upper part of bell thick, solid, and dome-like, and separated by an annular furrow from the thin-walled, marginal part of bell. This furrow may be due to contraction (?) A very small, pointed apical projection arises sharply from the aboral surface of the evenly rounded dome of the bell. There are 2 tapering tentacles about as long as the bell-height. These appear to have somewhat more swollen basal bulbs than are seen in *S. pterophylla*. There are no ocelli. There are a large number of rudimentary tentacle-bulbs as in *S. pterophylla*. The bell is transparent with yellow entoderm, and with orange to cinnabar-red gonads.

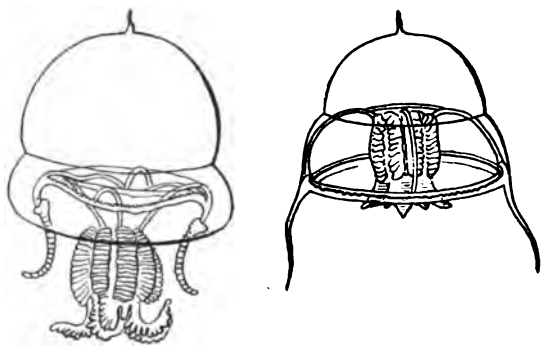

FIG. 61.—*Stomotoca divisa*, after Maas, in Mem. Museum Comp. Zool. at Harvard College, showing different states of contraction of the bell.

It is found in the Bay of Panama, Pacific coast of Central America, in March. It is distinguished from the closely allied *S. pterophylla* of the West Indies by its brilliant coloration, *S. pterophylla* being constantly dull-brown.

### Perigonimus jonesii Osborn and Hargitt.

Plate 11, figs. 3 and 4.

*Perigonimus jonesii*, OSBORN and HARGITT, 1894, Amer. Naturalist, vol. 28, p. 27, figs. 1-12.—HARGITT, 1895, Mittheil. Zool. Station Neapel, Bd. 11, p. 479; 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 33, 1 fig.; 1901, American Naturalist, vol. 35, p. 308, fig. 4; p. 579, fig. 37.—NUTTING, 1901, Bull. U. S. Fish Commission, vol. 19, pp. 331, 372, fig. 80.

*Young medusa.*—None of the specimens yet seen were mature. Bell of largest 2 mm. in height and side walls extremely thin and flexible. There is a very small, dome-shaped apical projection. There are 2 well-developed, diametrically opposed tentacles, which are situated at the bases of 2 of the radial-canals. These tentacles are of *unequal* length and are at times carried curled in a close helix and at other times are extended to their full length, in which case one of them becomes about as long as the bell-height, while the other attains to about twice this length. The basal bulbs of these tentacles are long, conical, and hollow and have no ocelli, and the shafts of the tentacles are thickly covered with nematocyst-cells. In addition to these well-developed tentacles, there are 2 small tentacle-bulbs, situated at the bases of the 2 radial-canals 90° away from the long tentacles. There are no ocelli. The velum is wide and flexible. There are 4 straight, slender radial-canals and a narrow, circular tube. The manubrium is short and simple, with a wide base and 4 simple, cruciform lips.

The ectoderm of the manubrium and tentacle-bulbs is of a dull ocher-yellow.

This medusa is very rare; only 3 specimens have been seen by me during 3 summers' study. All of my specimens were found in Newport Harbor, Rhode Island, during July and August.

*Hydroid.*—The hydroid has been described by Osborn and Hargitt, 1894, from Cold Spring Harbor, Long Island, New York, where it is found very commonly upon the abdomen and upon the walking legs of the spider-crab (*Libinia emarginata*). It is a *Perigonimus*. The stems arise from a creeping hydrorhiza and branch luxuriantly. The oldest polypite is found at the distal end of the stem. The stems are covered with a thick gelatinous perisarc which extends up the stems to the level of the tentacles, to which it is fastened. There are normally 16 tentacles in a single circlet around the base of the hypostome. These assume an alternately reflected position. The medusa-buds arise in clusters from near the center of the stems. They are covered with the thick perisarc and each one is attached to the stem by means of a well-developed peduncle. When set free the medusa has 2 diametrically opposed tentacles which are usually carried turned inward into the bell-cavity. The hydroid is flesh-colored.

The medusa can at once be distinguished from *S. apicata* by the extreme tenuity and flexibility of the bell-walls. The bell is also higher and narrower than in *S. apicata* The

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medusa swims by the aid of a rhythmical series of wave-like contractions which travel one after another up the very flexible sides of the bell, from margin to apex. The efficiency of these movements is greatly enhanced by the cooperation of the powerful velum.

The fully-developed medusa is unknown and it is possible that this medusa may not be *Stomotoca*. It can not be referred to any *Turris* known upon our coast, and the fact that the 2 long tentacles are of unequal length, one being considerably longer than the other, separates it at once from any other known species of *Stomotoca*. At present we place it provisionally in the genus *Stomotoca* to which its hydroid appears to refer it. Were it not for the absence of ocelli upon the tentacle-bulbs I would be inclined to suspect that this medusa might prove to be the young of *Turris pileata*.

**(Stomotoca?) Perigonimus cidaritis Weismann.**

*Perigonimus cidaritis*, WEISMANN, 1883, Entstehung Sexualzellen bei Hydromedusen, pp. 117, 218, taf. 12, figs. 10, 11.

The stems of the hydroid are about 90 mm. high and arise thickly one by the side of the other from a root-like hydrorhiza. The stems are often simple and unbranched, but they commonly branch dichotomously one or two times, the branches being set off at acute angles one with another. The hydranths have a circlet of about 20 tentacles. Perisarc thin and yellowish. The medusa-buds are borne upon pedicels in a zone at the bases of the hydranths. When set free the medusa is spherical, with 4 marginal tentacles and 4 radial-canals. The manubrium has 4 short, knobbed oral tentacles. The whole hydroid stock is invested with a thin layer of slimy mud, leaving only the mouth-ends of the hydroids projecting, and sometimes even those are covered, leaving only the tentacle tips free.

Found at Naples, Italy. Medusa set free in March.

The sex-cells originate in the ectoderm of the proximal part of the manubrium of the medusa-bud and develop in their place of origin, becoming mature in the free medusa. The mature medusa has not been determined.

**Genus DISSONEMA Haeckel, 1879.**

*Dissonema*, HAECKEL, 1879, Syst. der Medusen, p. 126.—MAYER, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 44.—BIGELOW, H. B., 1909, Bull. Museum of Comp. Zool. at Harvard College.

This genus was founded by Haeckel, 1879, for *Dissonema saphenella*, of the coast of Australia.

GENERIC CHARACTERS.

Tiarinæ with two hollow, diametrically opposite tentacles. The gonads extend from the manubrium outward along the canals. Without marginal sense-clubs. Cirri are sometimes present. With abaxial, ectodermal ocelli upon the bases of the tentacles.

Bigelow, 1908, finds that the adradial gonads begin to develop upon the sides of the manubrium and that afterwards they extend outward over the radial-canals. The hollow tentacles, abaxial ectodermal ocelli, rudimentary tentacle-bulbs, and hollow bell-apex are all characteristic of the Tiarinæ, and it appears that this genus must be removed from the Thaumantiadæ, in which Haeckel placed it.

*Dissonema* bears the same relation to *Stomotoca* that *Nemopsis* does to *Bougainvillia*. The hydroid is unknown.

**Dissonema saphenella Haeckel.**

*Dissonema saphenella*, HAECKEL, 1879, Syst. der Medusen, p. 126, taf. 8, fig. 3.

Bell pyriform, with thick, solid apex and thin, bulging sides. 6 mm. high, 4 mm. wide. 2 well-developed tentacles, several times as long as the bell-height. These tentacles have large, swollen, conical basal bulbs. There are 2 rudimentary tentacle-bulbs 90° apart from the long tentacles. There is an abaxial (ectodermal?) "ocellus" of large size upon each of the 4 tentacle-bulbs. There are no marginal clubs, cirri, or other appendages.

The velum is well-developed and there are 4 straight, narrow radial-canals and a ring-canal. The manubrium is cylindrical, half as long as the depth of the bell-cavity and provided with 4 short, crinkled lips. The 4 folded, spindle-shaped gonads are developed upon the middle three-fourths of the radial-canals. Color (?) Coast of Australia. (See fig. 62.)

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### Dissonema turrida Mayer.

Plate 10, fig. 1; plate 22, fig. 1.

*Dissonema turrida*, MAYER, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 44, plate 2, figs. 3, 4; 1904, Mem. Nat. Sci. Brooklyn Institute Museum, vol. 1, p. 8, plate 2, fig. 10.

*Adult medusa.*—Bell bluntly cone-shaped with a hollow apical projection. It is 4 to 7 mm. high and the side walls are thin and flexible. There are 2 long, hollow, gradually tapering tentacles which are quite contractile, but when expanded are 3 to 4 times as long as the bell-height. Each of these tentacles has a minute, red ocellus in the ectoderm of its outer side near the bell-margin. In addition to the two large tentacles there are 12 to 14 small, solid cirri which arise separately, at equal intervals, from the bell-margin. Each cirrus has a red ocellus in the ectoderm of its outer (abaxial) side at the bell-margin. The velum is well developed. The circular vessel is narrow, but the 4 radial-canals are broad, and the 4 convoluted, bag-like gonads occupy three-quarters of their length and also lie upon the adradial sides of the manubrium. In the female each gonad contains 4 to 7 large eggs which project prominently over the surface of the organ. The manubrium is pyriform and the mouth projects beyond the velar opening. The stomach-walls are thin and flexible, and the mouth is surrounded by large recurved lips with crinkled edges. The entoderm of the manubrium and tentacles is a delicate green and the genital organs and circular canal are tinged with green or pink. The ocelli are red.

FIG. 62.—*Dissonema saphenella*, after Haeckel, 1879.

In young medusæ there are but 2 large tentacles and 2 cirri. There are 8 ocelli. The 2 long tentacles have tapering, hollow basal bulbs, but their main shafts are at first solid, though later they become hollow.

This medusa is common on the surface in the Bahamas and at Tortugas, Florida, in summer.

Dr. H. B. Bigelow shows as a result of sectioning the medusa of *Dissonema* that the gonads begin to develop upon the adradial sides of the manubrium and later extend outward down the radial-canals. This fact, taken in connection with the abaxial ectodermal ocelli, the hollow tentacles, bell-apex, rudimentary tentacles and general form of the medusa, make it evident that *Dissonema* is one of the Tiarinæ.

### Genus PANDEA Lesson, 1843.

*Pandea*, LESSON, 1837, Prodrom. Monog. Meduses, No. 22 (not published); 1843, Hist. Zooph. Acal., p. 288.—AGASSIZ, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 347.
*Pandæa*, HAECKEL, 1879, Syst. der Medusen, p. 53.
*Pandea*, AGASSIZ and MAYER, 1899, Bull. Mus. Comp. Zool. at Harvard College, vol. 32, p. 160.—HARTLAUB, 1892, Nachricht. kgl. Gesell. Wissenschaft. Univ. Göttingen, p. 21.—MAAS, 1904, Résult. Camp. Sci. Prince de Monaco, fasc. 28, p. 15.
*Dianæa*, QUOY ET GAIMARD, 1827, Annal. des Sci. Naturelles, tome 10, plate 6.
*Non Dianæa*, LAMARCK, 1816, Hist. Anim. sans Vert., tome 2, p. 505.
*Pandæa*, ZOJA, 1892, Boll. Sc. Paira, Anno 1891, Nos. 3, 4, 3 pp.; 1892, Annals and Mag. Nat. Hist., ser. 6, vol. 9, p. 409. (*Dendroclava dohrnii* gives rise to a medusa resembling *Pandea*?)

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The type species of *Pandea* is *P. conica* Lesson, 1843. This medusa was previously described by Quoy and Gaimard (1827, Annal. Sci. Nat., tom. 10, p. 182, plate 6) under the name *Dianæa conica*. It is found in the Mediterranean. Haeckel introduced the spelling "*Pandæa*," although Lesson's original spelling is *Pandea*. The genus "*Dianæa*" was founded by Lamarck (1816, Hist. Anim. sans Vert., tom. 2, p. 505), the type species being *Dianæa triedra*, a medusa which had been previously described by Péron under the generic name of *Lymnorea*. Lamarck's genus *Dianæa* also included various species of *Geryonia*, *Oceania*, *Pelagia*, and *Medusa* of previous authors, and is so hopelessly involved that in my opinion it must be dropped.

### GENERIC CHARACTERS.

Tiarinæ with 4 or more well-developed, marginal tentacles. There are 4 interradial, genital ridges in the ectodermal wall of the stomach, but these gonads are only imperfectly separated in the 4 principal radii; so that the stomach is completely encircled by the genital organs, which are, however, better developed in the interradii than in the principal radii.

*Dendroclava* is possibly the hydroid of some species of *Pandea*, *Conis*, or *Turris*, but the mature medusa is unknown.

When set free the medusa of *Dendroclava dohrnii* (Weismann, 1883, pp. 26, 216, taf. 12, fign. 6-9) has 8 marginal tentacles, 4 radial-canals, and a manubrium with 4 band-like gonads

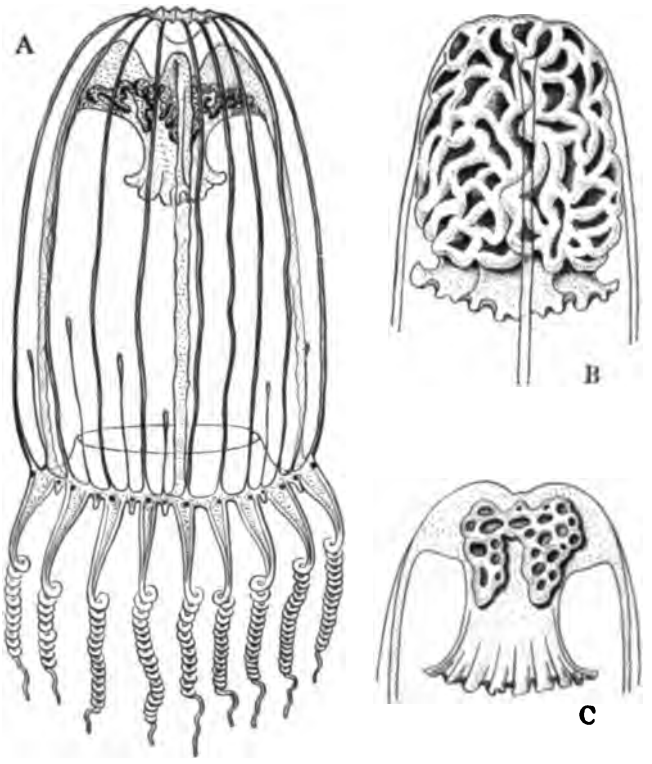


FIG. 63.—*Pandea conica*.

A. Side view of half-grown medusa. Bell 13 mm. high. Gonads interradial.
B. Manubrium of mature medusa, with bell 21 mm. high. Gonads confluent, surrounding stomach.
C. Manubrium of young medusa, showing interradial gonads. Bell 6 mm. high. From life, by the author. Zoological Station, Naples. Winter of 1907-08.

on its interradial sides. The sexual cells originate in the ectoderm of the manubrium of the medusa-bud and develop in the ectoderm of the free-swimming medusa, without wandering from their place of origin. The hydroid of *Dendroclava dohrnii* was found by Weismann at Naples in the summer of 1881, attached to a stock of *Isis* which was dredged from a depth of 35 to 40 fathoms. The stems are about 35 mm. high and arise from a short, creeping hydrorhiza, which together with the stems is covered by a smooth, horny perisarc. The main stems

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give rise to alternate side branches. The hydranths are club-shaped and bear 12 to 20 short, filiform tentacles, scattered over their whole sides. The medusa-buds arise singly from the side branches close under the neck of the lateral hydranths. Pictet, 1893, found a very similar or identical hydroid at Amboina, Malay Archipelago. The principal references to this clava-like hydroid are as follows:

*Dendroclava dohrnii*, Weismann, 1893, Entstehung Sexualzellen bei Hydromedusen, Jena, pp. 26, 215, taf. 12, fign. 6–9.—du Plessis, 1888, Recueil Zool. Suisse, tome 4, p. 531 (from Villefranche).

*Dendroclava dohrni*, Pictet, 1893, Revue Suisse Zool., tome 1, p. 6, plate 1, figs. 1, 2 (from *Amboina*).

It does not seem probable that *Dendroclava dohrni* produces a Pandea-like medusa, for it is well established by Brooks that *Turritopsis nutricula* comes from a *Dendroclava* hydroid.

**Pandea conica Lesson.**

*Dianæa conica*, Quoy et Gaimard, 1827, Annal. des Sci. Nat., tome 10, p. 182, plate 6 A, figs. 3, 4.
*Pandea conica*, Lesson, 1843, Hist. Zooph. Acal., p. 288.—Haeckel, 1879, Syst. der Medusen, p. 54.—Maas, 1904, Résult. Camp. Sci. Prince de Monaco, fasc. 28, p. 16, plate 1, figs. 6, 7 (figures of gonads).—Bedot, 1905, Revue Suisse de Zool., tome 13, p. 141 (literature, 1827–50).—Lobianco, 1903, Mitth. Zool. Sta. Neapel, Bd. 16, p. 217.
*Oceania sedecimcostata*, Kölliker, 1853, Zeit. für wissen. Zool., Bd. 4, p. 324.
*Oceania conica*, Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, p. 221, taf. 7, fign. 1–3.

Bell with barrel-shaped sides, and bluntly pointed or concave apex; 21 mm. high, 10 mm. wide. There are 8 to 24 well-developed, longitudinal rib-like ridges in the tentacular radii on the exumbrella, and an equal number of marginal tentacles with abaxial ectodermal ocelli. Stomach wide and short with 4 folded lips having sinuous margins. The gonads consist of 4 crescentic, reticulated, swollen regions in the ectoderm of the 4 interradial sides of stomach, the convexity of the horseshoe pointing aborally. These gonads are not completely separated in the adult, in the 4 principal radii, so that they surround the stomach on all sides.

The best figures illustrating their structure are given by Maas, 1904.

| Height of bell in mm. | No. of tentacles. | Condition of the gonads. |
|---|---|---|
| 6 | 16 | 4 small interradial. |
| 8 | 16 | 4 larger interradial. |
| 13 | 21 | 4 interradial nearly touching in the perradii. |
| 21 | 24 | A unitary network of ridges surrounding the stomach. |

Stomach brownish. Gonads and tentacle-bulbs brownish-red. Tentacles yellowish-milky. Ocelli dark-purple.

Common in the Mediterranean.

This medusa was quite common during the winter of 1907-1908 at Naples, Italy. When young the 4 interradial gonads are completely separated, but later they fuse more or less over the perradii, forming a complete, swollen network which girdles the stomach.

The prominent longitudinal ridges over the exumbrella arise after the tentacles begin to develop and extend upward from the bases of the tentacles toward the bell-apex. The table gives a growth-record obtained by the author from specimens of this medusa observed at Naples. (See fig. 63, page 117.)

**Pandea saltatoria Lesson.**

*Oceania saltatoria*, Sars, 1835, Beskriv og Jagtt., p. 25, plate 4, fig. 10*a–c*.
*Pandea saltatoria*, Lesson, 1843, Hist. Zooph. Acal., p. 290.—Haeckel, 1879, Syst. der Medusen, p. 54.—Bedot, 1901, Revue Suisse de Zool., tome 9, p. 485; *Ibid.*, 1905, tome 13, p. 141 (all literature to 1850).

Bell 8 mm. high, 6 mm. wide, with a pointed apex and rounded sides. Exumbrella with only 12 to 16 longitudinal lines of nettling-cells instead of about twice as many as in *P. conica*. 24 to 32 tentacles; twice as many as the lines of nematocysts, instead of being equal to these in number as in *P. conica*. Ocelli on outer sides of tentacle-bulbs. Stomach slender, lips small and simple. Immature (?) Color (?) Coast of Norway, Bergen.

**Pandea minima von Lendenfeld.**

*Pandæa minima*, von Lendenfeld, 1884, Proc. Linnean Soc. New South Wales, vol. 9, p. 916, plate 42, figs. 10–12.

Bell semi-ovate, 3 mm. high, 2 mm. wide. 8 tentacles about as long as bell is high. 8 adradial lines of nettle-cells upon the exumbrella. A bundle of nerve fibers is said to extend under each linear series of nettle-cells connecting the clusters one with another! The man-

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## Plate 12.

Fig. 1. *Pandea violacea*, mature female. Tortugas, Florida, June 5, 1906.
Fig. 2. *Turris vesicaria*, young medusa. Eastport, Maine, September 19, 1898.
Fig. 3. *Turris vesicaria*, half-grown medusa. Agassiz Laboratory, Newport, Rhode Island, June 24, 1893.
Fig. 4. *Turris pileata*, half-grown medusa. Agassiz Laboratory, Newport, Rhode Island, July 13, 1895.
Fig. 5. *Podocoryne fulgurans*. Basal part of one of the marginal tentacles.
Figs. 6 to 9. *Podocoryne fulgurans*. Views of manubrium showing medusa-buds. Agassiz Laboratory, Newport, Rhode Island, September, 1892.

Drawn from life, by the author.

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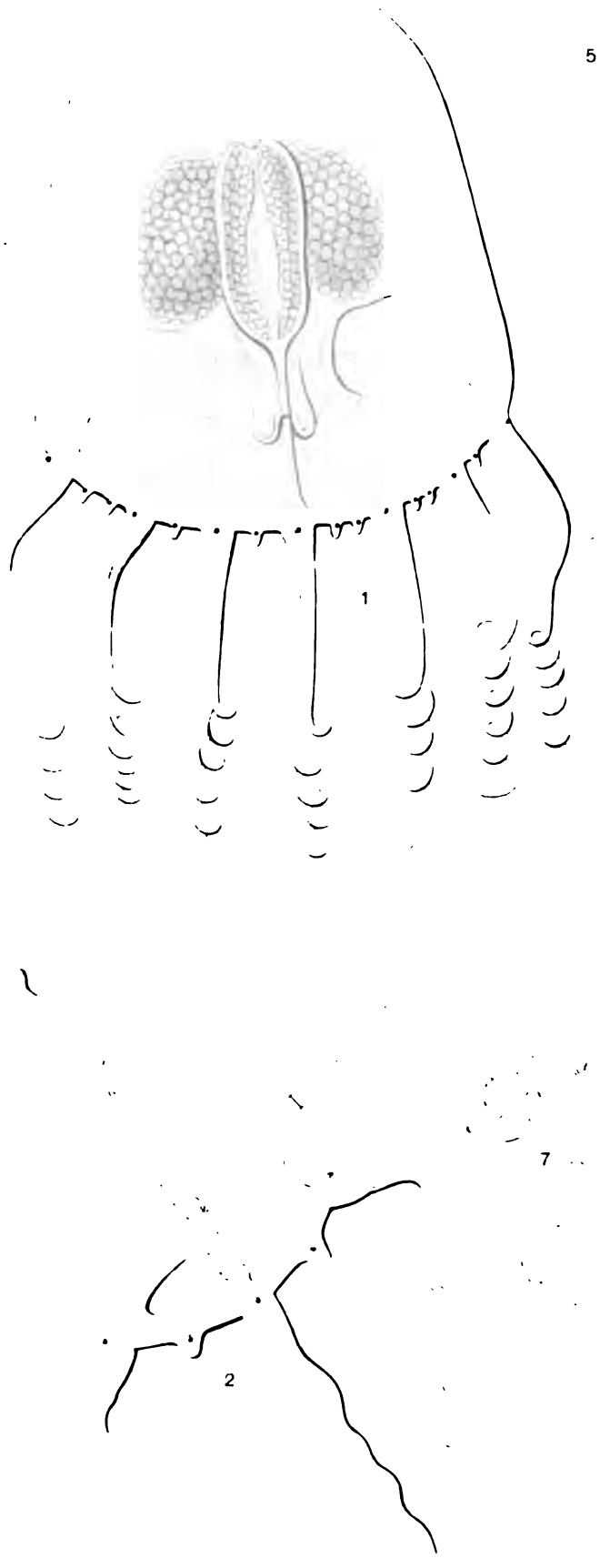

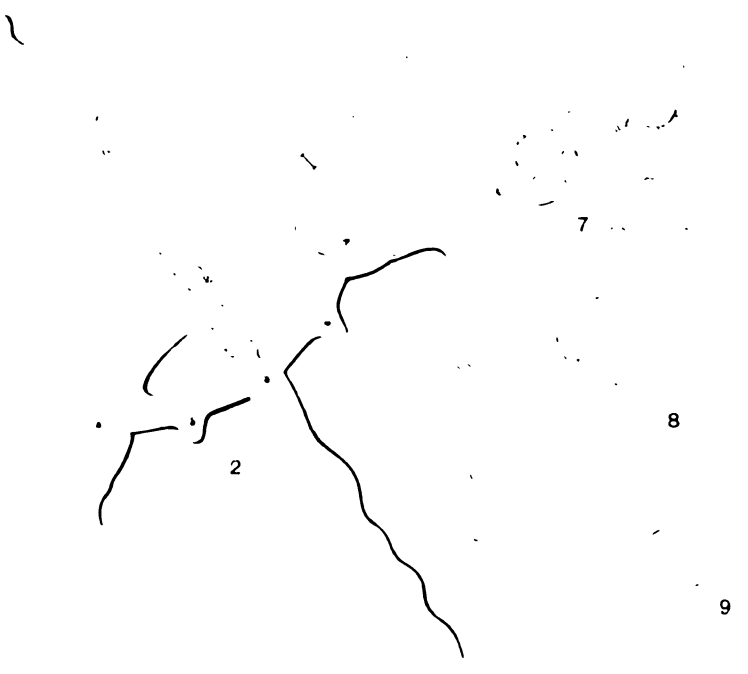


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ubrium is slender and about half as long as the depth of the bell-cavity. 4 small lips. 4 longitudinal gonads on the stomach. These are narrow folds with smooth outer surfaces. Bell light-pink, with the 8 adradial lines of nematocysts more intense in color. Stomach and tentacle-bulbs light-brown.

Found in Sydney Harbor, New South Wales, Australia, in August and September.

**Pandea violacea Agassiz and Mayer.**

Plate 11, fig. 7; plate 12, fig. 1.

*Pandea violacea*, Agassiz, A., and Mayer, 1899, Bull. Mus. Comp. Zool. at Harvard College, vol. 32, p. 160.—Mayer, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 34, plate 1, fig. 1.
*Pandea, sp.*, Lobianco, 1903, Mitth. Zoolog. Sta. Neapel, Bd. 16, p. 217, tav. 7, fig. 1.

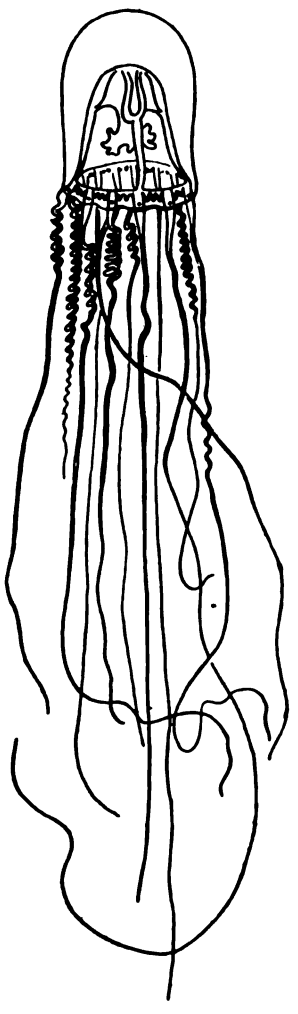

Fig. 64.—*Pandea violacea*, after Lobianco, Mitth. Zool. Sta. Neapel, 1903.

Bell pear-shaped and 7.5 mm. high, with moderately thick walls. There are about 32 tentacles. 8 to 12 of these are about 3 times as long as the bell-height and 24 are small and rudimentary. The long tentacles are all of equal length. Their basal bulbs are long, tapering, and hollow. There are 1 to 3 rudimentary tentacle-bulbs between each successive pair of long tentacles. There are about 32 ectodermal, purple ocelli, one on the outer side of each tentacle-bulb. The velum is well developed. The manubrium is flask-shaped and quadratic in cross-section. The outer surfaces of the adradial gonads are smooth and without corrugations (plate 11, fig. 7). The mouth is at the extremity of a well-developed neck and is at about the level of the velar opening. There are 4 large, slightly recurved lips with smooth, simple edges. There are 4 straight, narrow radial-canals and a broad circular vessel. The entoderm of the manubrium and tentacle-bulbs is delicate pink and in some specimens a green streak extends along the outer surface of the entodermal lining of the radial-canals. This medusa is common at the Tortugas, Florida, and among the Bahamas throughout the summer. An apparently identical species is found at Suva in the Fiji Islands, South Pacific, although the Pacific medusa is not so highly colored.

A closely related, if not identical, medusa is described by Lobianco, 1903, from two specimens drawn from depths of 500 to 600 fathoms near Capri, Bay of Naples, Italy. Dr. Lobianco kindly permitted me to study these specimens. The bell is 11 mm. high, 7 mm. wide; thick-walled, with dome-like apex. There are 12 to 13 long tentacles, 4 to 5 times as long as the bell-height. These have long, hollow, tapering basal bulbs, each with an abaxial, dark-red ectodermal ocellus. In addition to the long tentacles there are about 24 to 36 very short rudimentary marginal tentacles, each with an abaxial ocellus. The 4 radial-canals are quite wide and with slightly jagged outlines. The manubrium is half as long as the depth of the bell-cavity. The 4 complexly folded lips are at the end of a well-developed neck. The outer surfaces of the adradial gonads are smooth. The entoderm is strawberry-pink. I can not separate this medusa from *Pandea violacea* of Tortugas, Florida, some specimens of which are fully as pink in color as is the one shown in Lobianco's figure.

**Pandea maasi.**

*Tiara, sp.*, Maas, 1904, Résult. Camp. Sci. Prince de Monaco, fasc. 28, p. 13, plate 2, fig. 11.

Bell 10 to 13 mm. high and only about half as wide as high, with a smooth exumbrella surface. Bell-walls quite thick, with an evenly rounded apex, without an apical projection. 4 thick, hollow tentacles at the bases of the 4 radial-canals. These have large, swollen basal bulbs, but no ocelli were observed. The tentacles are about as long as the bell-height and

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ubrium is slender and about half as long as the depth of the bell-cavity. 4 small lips. 4 longitudinal gonads on the stomach. These are narrow folds with smooth outer surfaces. Bell light-pink, with the 8 adradial lines of nematocysts more intense in color. Stomach and tentacle-bulbs light-brown.

Found in Sydney Harbor, New South Wales, Australia, in August and September.

### Pandea violacea Agassiz and Mayer.

Plate 11, fig. 7; plate 12, fig. 1.

*Pandea violacea*, Agassiz, A., and Mayer, 1899, Bull. Mus. Comp. Zool. at Harvard College, vol. 32, p. 160.—Mayer, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 34, plate 1, fig. 1.
*Pandea, sp.*, Lobianco, 1903, Mitth. Zoolog. Sta. Neapel, Bd. 16, p. 217, tav. 7, fig. 1.

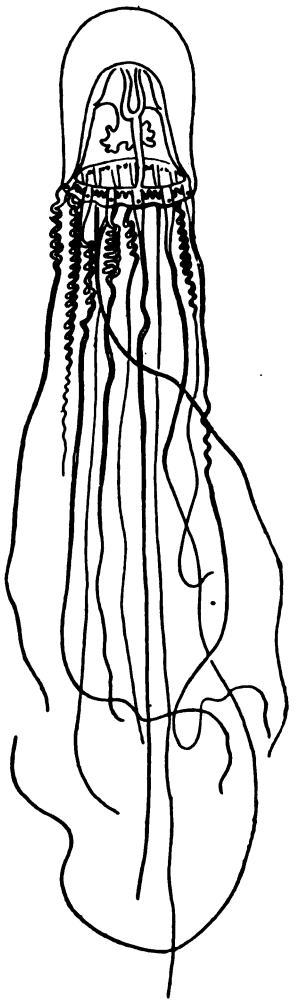

Fig. 64.—*Pandea violacea*, after Lobianco, Mitth. Zool. Sta. Neapel, 1903.

Bell pear-shaped and 7.5 mm. high, with moderately thick walls. There are about 32 tentacles. 8 to 12 of these are about 3 times as long as the bell-height and 24 are small and rudimentary. The long tentacles are all of equal length. Their basal bulbs are long, tapering, and hollow. There are 1 to 3 rudimentary tentacle-bulbs between each successive pair of long tentacles. There are about 32 ectodermal, purple ocelli, one on the outer side of each tentacle-bulb. The velum is well developed. The manubrium is flask-shaped and quadratic in cross-section. The outer surfaces of the adradial gonads are smooth and without corrugations (plate 11, fig. 7). The mouth is at the extremity of a well-developed neck and is at about the level of the velar opening. There are 4 large, slightly recurved lips with smooth, simple edges. There are 4 straight, narrow radial-canals and a broad circular vessel. The entoderm of the manubrium and tentacle-bulbs is delicate pink and in some specimens a green streak extends along the outer surface of the entodermal lining of the radial-canals. This medusa is common at the Tortugas, Florida, and among the Bahamas throughout the summer. An apparently identical species is found at Suva in the Fiji Islands, South Pacific, although the Pacific medusa is not so highly colored.

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### Pandea maasi.

*Tiara, sp.*, Maas, 1904, Résult. Camp. Sci. Prince de Monaco, fasc. 28, p. 13, plate 2, fig. 11.

Bell 10 to 13 mm. high and only about half as wide as high, with a smooth exumbrella surface. Bell-walls quite thick, with an evenly rounded apex, without an apical projection. 4 thick, hollow tentacles at the bases of the 4 radial-canals. These have large, swollen basal bulbs, but no ocelli were observed. The tentacles are about as long as the bell-height and

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their shafts are of about uniform width throughout, the outer ends being very blunt, not tapering. There are no other tentacles or marginal appendages. The 4 radial-canals and the ring-canal are simple, narrow, and straight-edged; without glandular diverticula.

The stomach is wide and barrel-shaped to cylindrical and is about three-fourths as long as the depth of the bell-cavity. There is no peduncle and the 4 radial-canals run directly into the stomach without enlarging as they approach its base. The mouth is well developed, but the lips are simple, without the foldings commonly seen in other Tiarinæ.

The gonad is developed as an open network of more or less transverse folds over the ectodermal wall of the stomach, excepting only the neighborhood of the mouth. The gonad is not distinctly separated into 4 interradial parts, but is more or less fused over the perradial lines, thus encircling the stomach very much as in medusæ of the Codonidæ or in *Pandea conica*.

The entoderm is yellow, the gonads being deep in color and the tentacles lighter. Other parts are transparent.

Found by the Prince of Monaco at Bear Island, between Norway and Spitzbergen, in July, 1898. It is well figured and described by Maas, 1904. Hartlaub, 1907, considers this medusa to be identical with *Sarsia flammea* Hartlaub. The general proportions of the two medusæ appear to be much alike, but the details of structure of the gonads and the color of *P. maasi* appear to distinguish it from other medusæ.

## Genus TURRIS Lesson, 1843, sens. amend.

*Turris*+*Tiara* (in part), Lesson, 1837, Prodrom. Monog. Meduses, Nos. 17, 20 (not published); 1843, Hist. Zooph. Acal., pp. 283, 286.
*Turris*+*Oceania* (in part), Forbes, 1848, British Naked-eyed Medusæ, pp. 21, 26.
*Turris*+*Tiara*, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, pp. 346, 347.—Hartlaub, 1892, Nachricht. kgl. Gesell. Wissenschaft. Univ. Göttingen, pp. 20, 22.
*Turris*, Agassiz, A., 1865, North Amer. Acal., p. 164.
*Tiara*+*Turris*+*Catablema*, Haeckel, 1879, Syst. der Medusen, pp. 56, 60, 62.
*Turris*, Fewkes, 1881, Bull. Mus. Comp. Zool. at Harvard College, vol. 8, p. 147.
*Tiara*, Wagner, 1885, Wirbellosen des Weissen Meeres, p. 78.—Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 14.—Boveri, 1890, Jena. Zeit. Naturw., Bd. 24, p. 339. (The egg gives rise to 2 polar globules.)
*Catablema*+*Turris*+*Tiara*, Vanhöffen, 1891, Zool. Anzeiger, Bd. 14, p. 444.
*Catablema*+*Tiara*+*Turris*, Maas, 1904, Résult. Camp. Sci. Prince de Monaco, fasc. 28, pp. 12, 15, 16.

### GENERIC CHARACTERS.

Tiarinæ with 4 or more marginal tentacles. With 4 interradial horseshoe-shaped gonads in the stomach-wall. Each horseshoe composed of partially fused swollen ridges.

Lesson, 1843, describes three medusæ under the name *Turris*, only one of which belongs to the genus as we define it. This one is *Turris neglecta* of the north Atlantic coasts of Europe. The name *Tiara* was also proposed by Lesson, 1843, and is used to describe a medusa which was first observed by Forskål, 1775, under the name *Medusa pileata*. It is found off the Atlantic coast of Europe and in the Mediterranean.

I use *Turris* as equivalent to *Turris* Lesson + *Tiara* Lesson + *Catablema* Haeckel. Haeckel, 1879, p. 62, establishes *Catablema* for a Greenland medusa which he calls *Catablema campanula*.

Maas, 1904, who embodies the results of the studies of Vanhöffen, Hartlaub, and himself, defines *Turris* as having horseshoe-shaped interradial gonads, the sides of the horseshoe being made up of partially fused, transverse ridges while the arch connecting the two sides is composed of an irregular network of ridges. In *Tiara* the network is lacking, the entire horseshoe being composed of more or less transverse ridges. The ridges do, however, anastomose to some extent, so that an imperfect, partial network may be formed. *Catablema* he distinguishes by the jagged edges of its radial-canals and circular vessel. However, medusæ of *Turris* and *Tiara* often display jagged edges upon their canals, and this character is very variable and subject to much individual irregularity in development. In the young medusa of *Catablema* the ridges forming its interradial horseshoe-shaped gonads tend more or less longitudinally, but in later development they come to lie almost transversely as in *Turris* or *Tiara*. In order to terminate the confusion that has been introduced by these intergrading and too precise criteria for distinguishing the genera *Turris*, *Tiara*, and *Catablema*, I propose to unite them all under one genus and call it *Turris*, the name first used by Lesson to distinguish any of these medusæ.

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*Tabular Synopsis of the Species of Turris.*

| | T. papua Lesson. | T. rotunda = Tiara rotunda Haeckel.* | T. prismatica = Tiara prismatica Maas.† | T. reticulata Haeckel. | T. vesicaria A. Agassiz. |
|---|---|---|---|---|---|
| Size of bell in mm. | 28 high, 14 wide. Pointed apex. | 20 high, 20 wide. Cubical. | 20 high, 12 wide. | 12 high, 10 wide. | 25 high, 12 wide. |
| Number of tentacles. | 8 to 32 | 8 | 12 to 16 | 16 | 16 long, 48 short. |
| Ectodermal, abaxial ocelli on tentacle-bulbs. | Present. | Present. | ? | Present. | Present. |
| Character of edges of radial-canals. | Serrated. | Smooth. | Serrated. | Smooth. | Jagged. |
| Character of gonads. | 4 interradial horseshoes of complex, mainly transverse swellings which anastomose to some extent. | 4 pairs of adradial groups of cross-folds. | As in T. pileata. | 8 separate triangular areas in adradii of stomach, with complex anastomosing ridges. | Swollen, transverse, papilliform, anastomosing folds forming network in 8 adradii of stomach. |
| Color. | Tentacle-bulbs and stomach pink to dark-red. Gonads pink to dark-brownish-yellow. | Tentacle-bulbs, stomach, and gonads carmine. Radial-canals and ring-canal yellow. | ? | ? | Stomach and tentacle-bulbs cinnamon-brown. Gonads darker. Ocelli dark-red. |
| Where found. | Pacific and Indian Oceans in tropical regions. | Straits of Gibraltar. | Gulf Stream, Atlantic. | South Atlantic near Tristan d' Acunha. | Arctic Ocean to southern coast of New England, United States. |

| | T. superba Mayer.‡ | T. cœca Hartlaub. | T. pelagica Agassiz and Mayer. | T. conifera = Tiara conifera Haeckel.‡ | T. campanula = Catablema campanula Haeckel. |
|---|---|---|---|---|---|
| Size of bell in mm. | 5 high, 3.5 wide. | 30 high, 20 wide. | 16 high, 9 wide. | 25 high, 20 wide. | 20 high, 20 wide. |
| Number of tentacles. | 4 long, 12 short. | 24 to 30 of various lengths. | 30 short. All of same length. | 24 to 48. All long. | 24 to 48. All long. |
| Ectodermal, abaxial ocelli on tentacle-bulbs. | Present. | Not present. | Not present. | ? | Not present. |
| Character of edges of radial-canals. | Smooth. | Jagged. | Jagged. | ? | Jagged. |
| Character of gonads. | 4 interradial horseshoes of partially fused, mainly transverse ridges. | As in T. superba. | As in T. vesicaria. | Simple transverse ridges across the 8 adradii of stomach. | 4 crescent-shaped gonads in the 4 interradii of stomach. Each composed of longitudinal ridges side by side. No transverse folds. |
| Color. | Stomach emerald-green and pink to rose. Tentacle-bulbs rose-color. Entire gelatinous substance delicate pink. | Stomach pink, rose-colored, wine-colored. Tentacle-bulbs yellow. | All entodermal parts light port-wine-colored. | ? | Entodermal parts yellow. |
| Where found. | Tortugas and Bahamas in summer. | Mediterranean. | Pacific coast of Lower California. | Arctic Ocean, Russia, Greenland. | Arctic Ocean. |

*Probably an abnormal or stunted *T. pileata*. †Is this an abnormal individual of *T. pileata* (?)
‡Probably identical with *T. pileata*.



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According to Wright, 1859 (Edinburgh New Philosoph. Journ., plate 8, fig. 1) and Hincks, 1868 (British Hyd. Zooph., p. 14, plate 3, fig. 1), the egg of *Turris neglecta* develops into a Tubularian hydroid. *Clavula gossei* (see also Allman, 1871, Monog. Tubularian Hydroids, p. 259; also Metschnikoff, 1886, Arbeit. Zool. Inst., Wien, Bd. 6, p. 239) found that the eggs of *Tiara pileata* develop into a clava-like hydroid polyp. The hydroid polypites of *Turris* (*Clavula*) arise singly from a creeping stolon. Each polypite is slender, elongated, and claviform with scattered, elongate tentacles. The cœnosarc is invested by a polypary. It is possible that the hydroid described by Gegenbaur, 1854 (Verhandl. phys.-med. Gesell. Würzburg, Bd. 4, p. 165, taf. 1, figs. 3, 4) may prove to be the hydroid of *Turris*. The short, clavate polypites arise separately from a somewhat branching stolon, and each has 5 to 8 scattered, slender tentacles. The medusa-buds arise from the stolon and when set free each medusa has 2 long and 2 immature tentacles, and a line of nematocysts extends up from each tentacle-bulb to the top of the bell. Gegenbaur calls this form *Cleodora tricuspidata* or *Syncoryna cleodoræ*. Allman, 1871 (Monog. Tubularian Hydroids, p. 260) calls it *Campaniclava*.

It is probable that certain species of *Perigonimus* give rise to medusæ of the genus *Turris*.

*Corydendrium minor* Nutting, 1905 (U. S. Fish Commission Bulletin for 1903, p. 941, plate 2, fig. 1; plate 7, figs. 8, 9) from the Hawaiian Islands may be the hydroid of some *Turris*.

### Turris neglecta Lesson.

*Kermin beroe*, Slabber, 1778, Physikal. Belustig., Nürnberg, p. 110, plate 13, fig. 3.
*Turris neglecta*, Lesson, 1843, Hist. Zooph. Acal., p. 284.—Forbes, 1848, British Naked-eyed Medusæ, p. 23, plate 3, figs. 2*a*–2*i*.
*Oceania globulosa* (young?), Forbes, 1848, British Naked-eyed Medusæ, p. 29, plate 3, fig. 3.
*Turris neglecta* (hydroid?), Gosse, 1853, Nat. Rambles Devonshire Coast, p. 348, plate 13, figs. 6–10.
*Clavula gossei*, Wright, 1859, Edinburgh New Phil. Journ, plate 8, fig. 1.
*Turris neglecta*, Hincks, 1868, Hist. British Hydroid Zooph., p. 13, plate 3, fig. 1.—Allman, 1872, Monog. Tubularian Hydroids, p. 259.—Haeckel, 1879, Syst. der Medusen, p. 62.—Bedot, 1901, Revue Suisse de Zool., tome 9, p. 488, *Ibid.*, 1905, tome 13, p. 152 (all literature to 1850).

*Tabular Synopsis of the Species of Turris*—Continued.

| | T. eurystoma = Catablema eurystoma Haeckel. | T. pileata = Tiara pileata L. Agassiz.* | T. neglecta Lesson.† | T. digitalis Forbes. | T. brevicornis Murbach and Shearer. |
|---|---|---|---|---|---|
| Size of bell in mm. | 40 high, 20 wide. | 40 high, 25 wide. | 6 high, 4 wide. | 40 high, 20 wide. | 45 high, 35 wide. |
| Number of tentacles. | 24 to 48. All long and 24 to 32 tentacle-bulbs. | 12 to 48. Usually 24 to 32. All well developed. | 60 to 70 short. | 50 to 100 short. | 140+ |
| Ectodermal, abaxial ocelli on tentacle-bulbs. | Not present. | Present. | Present. | ? | Not present. |
| Character of edges of radial-canals. | Jagged. | Slightly notched and jagged. | | Jagged. | Jagged. |
| Character of gonads. | Developed in longitudinal curtain-like folds of interradial sides of short stomach. | 4 interradial horseshoes of mainly transverse, somewhat anastomosing ridges. | As in T. pileata. | 8 adradia rows of transverse ridges. | As in T. pileata. |
| Color. | Stomach and gonads cherry-red. Canals and tentacles bright-red. | Variable. Stomach almost colorless, yellow, red, purple, brown. Radial-canals colorless, yellow, green. Tentacles colorless, pink. | Stomach, gonads, tentacle-bulbs scarlet, purple. | Stomach purple, reddish-brown. Tentacle-bulbs yellow, orange. | Tentacles, gonads, and stomach dark-red, purple. |
| Where found. | Coast of Greenland. | North Atlantic to Mediterranean. | British coasts. | Greenland to North Sea, British coasts. | St. Paul Island, Pribyloff Islands. North Pacific. |

* *T. conifera rotunda, superba* and *prismatica* are probably identical with *T. pileata*. Hydroid: *Perigonimus repens?*
† Hydroid: *Clavula gossei* Wright.

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PLATE 13.

Fig. 1. *Protiara formosa*, mature medusa. Tortugas, Florida, May 21, 1907. Oral view of female.

Fig. 2. *Protiara formosa*. One of the marginal cirri showing the chordate entodermal cells.

Figs. 3 to 5. *Podocoryne fulgurans*. Agassiz Laboratory, Newport, Rhode Island, September, 1892.

Fig. 6. *Turris pileata*, young medusa. Agassiz Laboratory, Newport, Rhode Island, September 25, 1896.

Fig. 7. *Turris vesicaria*, mature medusa. Eastport, Maine, August, 1897.

Drawn from life, by the author.

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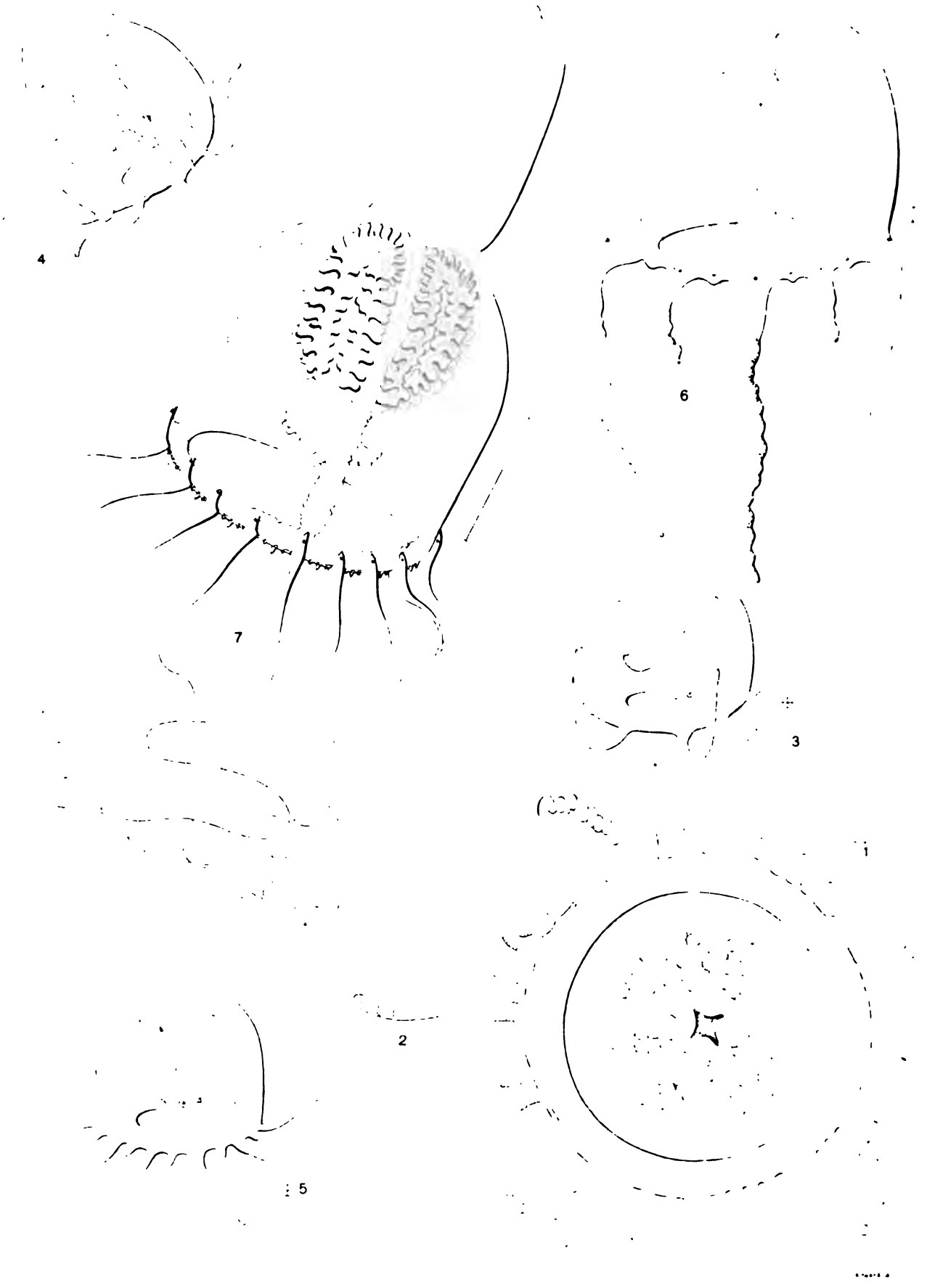


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Bell 4 to 6 mm. high, 3 to 4 mm. wide. Globular or with a conical apex and bulging sides; margin somewhat constricted. 60 to 70 short, crowded tentacles, shorter than the bell-height, with abaxial ocelli. Stomach wide, cruciform in cross-section, and one-half to two-thirds as long as the depth of the bell-cavity. 4 simple lanceolate lips, not complexly folded. Gonads as in *T. pileata*. Entoderm of stomach and tentacle-bulbs reddish-brown to rich purple. Found off the British coasts.

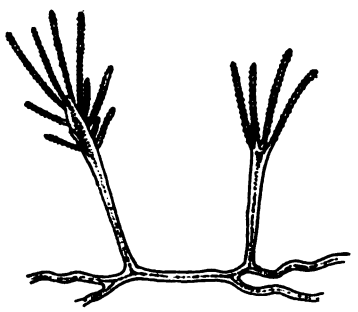

FIG. 65.—Hydroid of *Turris neglecta*, after Hincks, in British Hydroid Zoophytes.

The hydroid was obtained by Grosse and Wright, who reared it from the egg. The planula is bright crimson. The hydranths are club-shaped and only about 2.5 mm. high. They arise singly at intervals from a creeping filiform hydrorhiza and have 12 or more scattered, filiform tentacles. The hydrocaulus and hydrorhiza are invested by a perisarc. Hydranths bright crimson.

### Turris pileata.

Plate 12, fig. 4; plate 13, fig. 6.

*Medusa pileata*, FORSKÅL, 1775, Descriptiones Animal., p. 110; 1776, Icones rerum naturalium, plate 33, fig. D.
*Oceania pileata*+*P. Lesueur*, PÉRON ET LESUEUR, 1809, Ann. du Muséum d'Hist. Nat., tome 14, p. 345.
*Oceania* (*Charybdea*) *pisifera*, OKEN, 1815, Lehrbuch der Naturges., Teil 3, p. 125.
*Oceania ampullacea*, SARS, 1835, Beskriv og Jagttagelser, p. 22, plate 4, fig. 8*a–f*.
*Tiara papalis*+*T. sarsii*, LESSON, 1843, Hist. Zooph. Acal., p. 287.
*Oceania turrita*+*O. octona*+*O. episcopalis*, FORBES, 1848, British Naked-eyed Medusæ, pp. 27, 28, plate 2, figs. 1–3.
*Oceania coccinea*, LEUCKART, 1856, Archiv. für Naturges., Jahrg. 22, p. 24.
*Phialidium ampullaceum*+*Tiara pileata*, AGASSIZ, L., 1862, Cont. Nat. Hist. U. S., vol. 4, pp. 352, 347.
*Tiara smaragdina*, HAECKEL, 1864, Jena. Zeit. für Naturw., Bd. 1, p. 336.
*Oceania pileata*, SPAGNOLINI, 1876, Catalogo Acalefi Mediterraneo, p. 21, tav. 3, fig. 1, 2.
*Tiara pileata*, HAECKEL, 1879, Syst. der Medusen, p. 58, taf. 3, fign. 6–8.—HAMANN, 1883, Zeit. für wissen. Zool., Bd. 38, p. 426, taf. 23, fign. 16–20 (development of the planula larva).—METSCHNIKOFF, E., 1886, Embryol. Studien an Medusen, pp. 29, 48, etc., taf. 1, fign. 1–17.—HARTLAUB, 1894, Wissen. Meeresuntersuch. Komm. Meere Kiel, Helgoland, Neue Folge, Bd. 1, p. 189.—FORSKÅL=*Oceania episcopalis* FORBES; BROWNE, 1896, Irish Naturalist, p. 180; 1895, Proc. and Trans. Liverpool Biol. Soc., vol. 9, p. 258.—BEDOT, 1901, Revue Suisse de Zool., tome 9, p. 487; *Ibid.*, 1905, tome 13, p. 150 (all literature to 1850).—BROWNE, 1903, Bergens Museums Aarbog, No. 4, p. 11.—MAAS, 1904, Résult. Camp Sci. Prince de Monaco, fasc. 28, p. 15, plate 1, fig. 9.—BROWNE, 1905, Proc. Royal Soc. Edinburgh, vol. 25, p. 760.
(?) *Tiara intermedia*, BROWNE, 1902, Annals and Mag. Nat. Hist., ser. 7, vol. 9, p. 277 (Falkland Islands, South Atlantic).
*Geryonia octona*, FLEMING, 1823, Edinburgh Philosoph. Journ., vol. 8, p. 299.
*Oceania octona*, FORBES, 1848, British Naked-eyed Medusæ, p. 27, plate 2, figs. 3*a–3d*. The plate is wrongly labeled "*O. episcopalis*."
*Oceania turrita* (young medusa), FORBES, 1848, British Naked-eyed Medusæ, p. 28, plate 2, figs. 2*a–2c*.
*Tiara octona*, AGASSIZ, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 347.
*Oceania coronata*, ALLMAN, 1871, Monog. Tubularian Hydroids, p. 33, fig. 8.
*Tiara octona*, HAECKEL, 1879, Syst. der Medusen, p. 57.
*Non Tiara octona*, MAAS, 1904, Résult. Camp. Sci. Prince de Monaco, fasc. 28, p. 13, plate 2, fig. 11.

Bell about 15 to 40 mm. high and 10 to 20 mm. wide. Side walls quite thin, but there is usually a well-developed, solid, apical projection, although this may be absent. This projection may be conical or cylindrical, with a basal constriction, or pineapple-shaped, etc. There are 12 to 48, usually 24 to 32, tentacles with hollow, laterally compressed, tapering basal bulbs. These tentacles are longer than the bell-height and there is an abaxial ocellus on the outer side of the base of each bulb. The velum is narrow and simple.

The 4 radial-canals and ring-canal are wide, flat, and ribbon-like and their edges are often more or less notched and jagged. As they approach the sides of the stomach the radial-canals widen out into funnel-like expansions, so that they embrace the upper halves of the sides of the stomach in the 4 principal radii.

The stomach is wide, balloon-shaped, and 4-sided, and fills the upper one-half to two-thirds of the bell-cavity. The 4 lips are at the end of a relatively narrow, short neck and are complexly folded, crenated and recurved upward.

The gonads are 4 horseshoe-shaped regions on the sides of the stomach, the sides of each horseshoe being adradial and the apex aboral and interradial. The horseshoe consists of an area of more or less transverse folds which, however, anastomose more or less so as to form a network of ridges. In young medusæ the ridges of the gonads are more or less parallel and transverse, but in later life they anastomose to form an irregular network.

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This medusa is very variable in color. The stomach ranges from yellow to red, or from brownish-red to purple. The radial and circular canals may be colorless, to yellow or green. The ocelli are red or dark brownish-purple. The tentacles range from colorless to light-purple.

It is widely distributed over the North Atlantic and in the Mediterranean, but it appears to be much commoner on the European than along the American coast.

The development has been studied by Hamann, 1883, and Metschnikoff, 1886. Segmentation is total and equal and a single-layered, elongate, ciliated larva is found. The entoderm develops from cells which wander into the central segmentation cavity from the hinder end of the larva, so that finally a two-layered planula is formed. The planula attaches itself and the hinder end develops into a hydrorhiza, while the forward end becomes the polypite. The hydrorhiza becomes invested with a thin perisarc and the polypite develops a mouth and 2 or 3 long thin tentacles, which arise at the base of the conical throat-tube. This stage was reached at the end of 16 days in Metschnikoff's specimens, and apparently the hydroid is one of the Clavidæ.

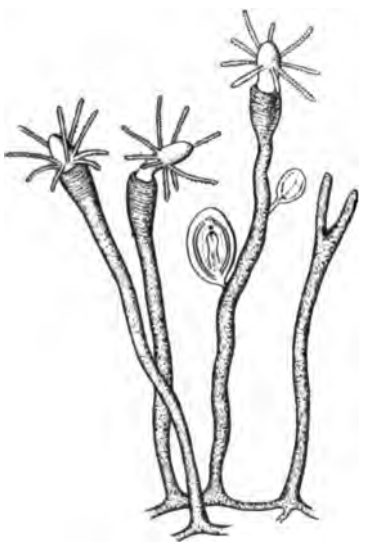

FIG. 66.—*Perigonimus repens*, after Hincks, in British Hydroid Zoophytes.

This hydroid may possibly be the very abundant and widely distributed *Perigonimus repens* (fig. 66) found off the Atlantic coasts of Europe from Russia southward, in the Mediterranean, off the Pacific coast of the United States, and at the Falkland Islands and Terra del Fuego, South America.

The stems of the hydroid branch and are covered with a gelatinous investment to which foreign bodies become attached. The polypites are spindle-shaped, with a single oral circlet of tentacles. The medusa-buds arise singly from the sides of the stems.

According to Hartlaub and Browne the medusa is set free with but 2 tentacles and 2 small tentacle-bulbs. Forbes described the 4-tentacle stage as *Oceania turrita*, the 8-tentacle condition as *O. octona*, and the medusa with 12 tentacles as *O. episcopalis*.

Some of the recent literature relating to the hydroid *P. repens* is here presented, though it must be borne in mind that this has not been *proven* to be the hydroid of the medusa in question.

*Perigonimus repens* + *P. minutus*, ALLMAN, 1872, Monog. Tubul. Hydroids, p. 321, plate 11.
*Perigonimus repens*, GRAEFFE, 1884, Arbeit. Zool. Inst. Wien., Bd. 5, p. 350. (At Trieste, Adriatic. Rare. Medusæ produced in May).—DU PLESSIS, 1888, Recueil Zool. Suisse, tome 4, p. 539.—BROWNE, 1896, Proc. Zool. Soc. London, p. 462 (*P. minutus* ALLMAN=*P. repens*).—BONNEVIE, 1899, The Norwegian North Atlantic Expedition, 1876–1878, vol. 26, Hydroids, p. 41 (from Norway).—CALKINS, 1899, Proc. Boston Soc. Nat. Hist., vol. 28, p. 339, plate 1, figs. 3–3 D (from Puget Sound).—TORREY, 1902, California Univ. Pub. Zool., vol. 1, p. 29 (Pacific coast, California to Washington).—HARTLAUB, 1905, Zoolog. Jahrbüchern, Suppl. 6, p. 530, fign. K, L, M (from the Falkland Islands and Terra del Fuego).

### Turris rotunda.

*Dianæa rotunda*, QUOY et GAIMARD, 1827, Annal. des Sci. Nat., tome 10, p. 181, plate 6 A, figs. 1, 2.
*Tiara rotunda*, HAECKEL, 1879, Syst. der Medusen, p. 57, taf. 3, fign. 9, 10.—BEDOT, 1905, Revue Suisse de Zool., tome 13, p. 151 (all literature to 1850).

Bell cubical without a pointed apex; 20 mm. high, 20 mm. wide. Bell-cavity only two-thirds as deep as the bell-height. 8 tentacles much longer than the bell-height, with conical basal bulbs. A large, dark-red ocellus on the outer side of each tentacle-bulb. Stomach small, swollen, globular, and confined to the upper third of the bell-cavity. The lips are short, much folded, and with a row of nettling warts around their edges. The gonads consist of 4 pairs of longitudinal, swollen areas, each thrown into 8 to 10 cross-foldings, on the adradial sides of the stomach. The stomach, gonads, and tentacle-bulbs are carmine, lips rose-red.

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Canals yellow. Found by Quoy and Gaimard, and later by Haeckel, in the Straits of Gibraltar. Development unknown.

### Turris papua Lesson.

*Turris papua*, Lesson, 1843, Hist. Zooph. Acalèphes, p. 283; Prodromus, 1837, No. 36.—Eydoux et Souleyet, 1841, Voyage de la *Bonite*, tome 2, p. 639, plate 2, figs. 1–3.—Haeckel, 1879, Syst. der Medusen, p. 58.—Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 14, taf. 2, fig. 13; 1906, Revue Suisse de Zool., tome 14, p. 88.—Bedot, 1905, Revue Suisse de Zool., tome 13, p. 150 (all literature to 1850).
*Æquorea mitra*, Lesson, 1829, Voyage de la *Coquille*, Zool., p. 127, plate 14, fig. 4.
(?) *Tiara oceanica*, Agassiz, A., and Mayer, 1902, Mem. Mus. Comp. Zool. at Harvard College, vol. 26, p. 141, plate 1, fig. 1.
(?) *Tiara intermedia*, Browne, 1902, Annals and Mag. Nat. Hist., ser. 7, vol. 9, p. 277.

Bell 28 mm. high, 14 mm. wide, with a solid apical projection and thin vertical walls. The longest tentacles are about as long as the bell-height and have elongate, conical, basal bulbs, with dark-red ectodermal ocelli on their outer sides. According to Lesson and to Eydoux et Souleyet there are 8 tentacles: 4 radial, 4 interradial. Maas found 16 tentacles: 4 radial, 4 interradial, and 8 adradial. Agassiz and Mayer found 32 tentacles: 8 long radial and interradial, 8 short adradial, and 16 very short intermediate tentacles. These differences may be local variations, but can hardly be due to the medusæ being in various stages of development, for Agassiz's specimen was only 5 mm. high and had 32 tentacles, while Browne's and Maas's specimens were 7 mm. high with only 16 tentacles. Moreover, Lesson's medusæ were larger and had only 8 tentacles. The 4 radial-canals are quite wide and have serrated edges. The stomach is wide, swollen, and the lips complexly folded, and about at the level of velar opening. The gonads are in 4 interradial, horseshoe-shaped series of transverse swellings on the sides of the stomach, the open ends of the horseshoe being directed downward toward the mouth and the apex being near the aboral end of the stomach.

The entoderm of tentacle-bulbs and stomach is pink to dark-red. The gonads are pink to dark brownish-yellow.

Widely distributed over the Indian Ocean and tropical Pacific.

It is probable that this form displays considerable variability in the number of its tentacles and in the color of its gonads. It is closely allied to *Turris superba* of Tortugas, Florida, and may be identical with *T. intermedia* Browne, from the Falkland Islands.

### Turris prismatica.

*Tiara prismatica*, Maas, 1893, Ergeb. der Plankton Exped., Bd. 2, K. c., p. 68, taf. 6, fign. 10, 11.

Bell about 20 mm. in height, 12 mm. in diameter; 4-sided and prismatic in shape. There is no apical projection and the bell-walls are remarkably thick. In the single specimen described by Maas there are 12 tentacles, one at the foot of each of the 4 radial-canals. 3 others in one quadrant, 3 in another, and one in each of the other quadrants. It seems probable that the specimen is abnormal and that there are normally 16 tentacles. The tentacles arise at a slight distance above the bell-margin. Ocelli (?) The gonads are similar to those of *Turris pileata*. In the preserved specimen the bell has a 4-sided prismatic shape. Color (?) A single individual of this species was found by the Plankton Expedition on August 4, 1889, in the Gulf Stream. May it not be an abnormal specimen of *Turris pileata* (?)

### Turris reticulata Haeckel.

*Tiara reticulata*, Haeckel, 1879, Syst. der Medusen, p. 60, taf. 3, fig. 11.

Medusa bell-shaped, 12 mm. high and 10 mm. broad. There is a small, conical, apical projection, about 1.25 times as high as it is broad. The stomach is 4-sided and pyramidal, widest below, and its radial edges are bound throughout their length by the 4 radial-canals. The 4 lips are large and much folded. There are 16 tentacles which are longer than the width of the bell, and have large, laterally compressed bases, with ocelli on their outer sides. There are 8 separate, triangular gonads in the outer wall of the stomach. The surfaces of the gonads display complex anastomosing folds and swellings.

This species was described by Haeckel from preserved specimens obtained in the South Atlantic near the Island of Tristan d'Acunha.

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### Turris vesicaria A. Agassiz.

Plate 12, figs. 2 and 3; plate 13, fig. 7.

*Turris vesicaria*, AGASSIZ, A., 1862, Proc. Boston Soc. Nat. Hist., vol. 9, p. 97; 1865, North Amer. Acal., p. 164, figs. 261–268.—NUTTING, 1901, Bull. U. S. Fish Commission for 1899, vol. 19, p. 375, fig. 86 (abnormal medusa).
*Catablema vesicarium*, HAECKEL, 1879, Syst. der Medusen, p. 64.—GRÖNBERG, 1898, Zool. Jahrb., Abth. Syst., Bd. 11, p. 461.
*Turris episcopalis*, FEWKES, 1881, Bull. Mus. Comp. Zool. at Harvard College, vol. 8, p. 147, plate 3, figs. 1–6.
*Turris vesicaria*, and *T. episcopalis*, HARGITT, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 36, 2 figs.
*Catablema vesicarium* (young medusa), MAAS, 1904, Résult. Camp. Sci. Prince de Monaco, fasc. 28, p. 12, planches 1, 2.

*Adult medusa* (plate 13, fig. 7).—Bell about 25 mm. in height and 12 mm. in diameter. There is a large, solid, apical projection which varies greatly in shape, being globular in some individuals, while in others it is cylindrical or conical. Its upper end is often seen to terminate in a small button-shaped projection. The side walls of the bell are quite thin and flexible. There are 16 well-developed tentacles, the basal bulbs of which are quite large and are flattened in a radial direction, so that the tentacle appears to arise from the side of the bell slightly above the bell-margin. These well-developed tentacles are very flexible, and when extended are about 2 to 4 times as long as the bell-height. These basal bulbs are hollow and bear each an abaxial ocellus. In addition to these long tentacles there are 48 very short, rudimentary tentacles, which arise from the bell-margin at a slightly lower level than the long tentacles. There are 3 of these rudimentary tentacles between each successive pair of long tentacles. There is a single dark-red ocellus upon the outer side of each and every tentacle-bulb, 64 in all. The velum is narrow. There are 4 broad, flat radial-tubes and a broad, circular canal, all of which display jagged edges. The 4 radial-canals enter the stomach by 4 wide, funnel-like openings. The manubrium is large and urn-shaped and there is no peduncle. The mouth is surrounded by 4 prominent, crenulated lips. The gonads occupy 4 interradially situated, longitudinal regions upon the walls of the stomach. Each gonad consists of a pair of swollen, papilliform, adradial, ectodermal ridges, the outer surfaces of which are thrown into complex, but mainly transverse, folds and corrugations. The color of the manubrium and tentacle-bulbs is cinnamon-brown, the gonads being of a somewhat darker shade. The ocelli upon the tentacle-bulbs are dark-red.

*Young medusa* (plate 12, fig. 2).—In the youngest medusa observed the bell is about 2 mm. in height. The walls are thin, and there is a short, conical, apical projection. There are only 4 well-developed tentacles, one at the base of each of the radial-canals. These tentacles have large conical basal bulbs which are hollow. The axes of the tentacle-bulbs are at a slight distance above the bell-margin. In addition to the 4 well-developed, radial tentacles, there are 4 intermediate interradial tentacles which arise from the bell-margin at a slightly lower level than the radial tentacles. The 4 radial-canals are broad and their edges are jagged. The manubrium is large and quadratic in cross-section. The lips are simple.

In a medusa 3 mm. in height (plate 12, fig. 3), there were 8 well-developed and 8 immature tentacles. The apical projection was large and miter-shaped, and the lips had folded, notched margins.

This medusa is probably an Arctic species. It has been found but rarely south of Cape Cod, and then only in May and June. It is abundant, however, in the harbor of Eastport, Maine, in August, and ample opportunities for observing its growth were afforded.

The medusa is remarkable for its voracity and will devour *Nanomia cara* with great avidity. It is a common thing to observe the medusa in the act of devouring one of these large Siphonophores which may be many times its own size. Maas, 1904, records this medusa off Bear Island, between Norway and Spitzbergen, so that its distribution is probably circumpolar. Grönberg records it as being rare in August off the coasts of Greenland and Spitzbergen.

### Turris superba (a variety of T. pileata).

Plate 27, fig. 8; plate 28, figs. 3 and 4.

*Tiara superba*, MAYER, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 34, plate 16, fig. 39; Memoirs Nat. Sci. Museum Brooklyn Inst. Arts and Sci., vol. 1, No. 1, p. 8, plate 2, fig. 11.

Bell 5 to 7 mm. high and with a well-developed apical projection. There are 4 long, hollow and 12 small, solid, rudimentary tentacles. The long tentacles are slender, with tapering basal bulbs. There is an ectodermal ocellus upon the outer side of the tentacle-bulb of

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each of the 16 tentacles. The velum is well developed. There are 4 broad, flat, smooth-edged radial-canals and a broad, simple, circular vessel. The 4 radial-canals enter the stomach by 4 wide funnel-like openings. The manubrium is wide and fills the greater part of the bell-cavity. The 4 lips are recurved and their edges much folded. The 4 gonads are developed on the interradial sides of the stomach. Each gonad is horseshoe-shaped, the apex of the horseshoe being uppermost, and the sides composed of partially fused, transverse ridges upon the ectoderm of the stomach-wall. The entire gelatinous substance of the medusa is of a delicate rose-pink.

The entoderm of the manubrium and tentacles is of a rich rose-color and the entodermal core of the stomach is emerald-green. This medusa is quite common at Tortugas, Florida, and among the Bahamas in the summer months. It is one of the most beautiful of American medusæ.

### Turris breviconis Murbach and Shearer.

*Turris breviconis*, MURBACH AND SHEARER, 1902, Annals and Mag. Nat. Hist., ser. 7, vol. 9, p. 73; 1903, Proc. Zool. Soc. London, vol. 2, p. 170, plate 18, figs. 1, 2.

Bell cubical, 45 mm. high, 35 mm. wide. More than 140 tentacles in double rows, with contractile muscles on their inner sides and enlarged ectoderm on their outer sides. No ocelli in preserved specimens. Gonads and stomach occupy less than half of the upper part of the bell-cavity. 4 broad radial-canals with unbranched lateral diverticula. Bell bluish, tentacles, gonads, and stomach dark-red or purple.

St. Paul Island, Pribyloff Islands, North Pacific.

### Turris cœca Hartlaub.

*Turris cœca*, HARTLAUB, 1892, Nachrichten kgl. Gesell. Wissen. Göttingen, p. 19, fig. 1.—MAAS, 1904, Résult. Camp. Sci. Prince de Monaco, fasc. 28, p. 17, planche 1, fig. 5.
*Tiarella parthenopaea*, TRINCI, 1907, Archiv. Ital. Anat. Embr. Firenze, vol. 5, p. 533 (development and structure of oocytes).

Bell about 30 mm. high and with 24 to 30 tentacles of various lengths. The tentacle-bulbs *lack ocelli*. The radial-canals are wide and flat and there are a few globular lobes along their edges. The stomach is wide and the lips complexly folded. The 4 interradial gonads are composed of horseshoe-shaped swellings. The ridges are lateral cross-folds in the 8 adradii, but in the interradius at the apex of the horseshoe, near the base of the stomach, they form a reticulated network.

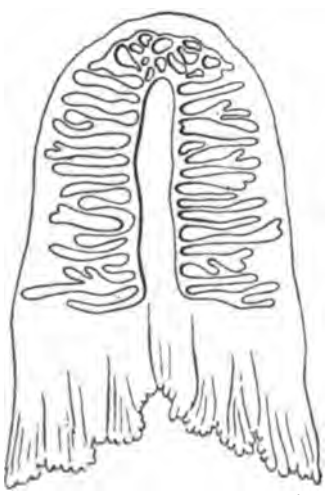

FIG. 67.—Gonad of *Turris cœca*, after Maas, in Résult. Camp. Sci. Prince de Monaco.

The stomach is rose-colored to wine-colored, and the tentacle-bulbs are yellow.

Found at Naples and Monaco, Mediterranean, in February and March.

### Turris pelagica Agassiz and Mayer.

*Turris pelagica*, AGASSIZ, A., and MAYER, 1902, Mem. Museum Comp. Zool. at Harvard College, vol. 26, p. 142, plate 1, fig. 2.

Bell 16 mm. in height and 9 mm. wide, and the sides are barrel-shaped, being wider at the middle than at either end. There is a small, solid, apical projection. The bell-walls are very thin and quite flexible. There are about 30 short tentacles, less than half as long as the bell-height, all being of the same size. These tentacles all arise from the bell-margin and their bases are large and conical. There are no ocelli. The velum is well developed. There are 4 radial tubes which are flat and quite broad, being narrower near the circular canal than at any other place. Their outer edges are jagged, excepting in the narrow parts near the circular canal. The manubrium is large and fills the greater part of the bell-cavity. It is joined to the 4 radial-canals by means of 4 wide funnel-shaped ducts. The gonads occupy 8 adradially situated rows which extend about two-thirds of the distance from the inner apex of the bell-cavity to the velar opening. The outer surfaces of the gonads are transversely folded and give rise to numerous papillæ. There are 4 well-

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developed, complexly folded lips. The lips and tentacle-bulbs are of a light port-wine color and the gonads and radial-canals are of a still lighter shade. A single specimen of this medusa was found in a surface haul on August 26, 1899, off the Pacific coast of Lower California; N. lat. 31° 10′, W. long. 125°. It is separated from *T. papua* and *T. pileata* by the absence of ocelli.

**Turris conifera Haeckel.**

*Tiara conifera*, HAECKEL, 1879, Syst. der Medusen, p. 59.—FEWKES, 1888, Report on Medusæ of the Lady Franklin Bay Expedition, p. 43.—LEVINSEN, 1893, Vid. Meddel. Nat. For. Kjöbenhavn (5), Bd. 4, p. 144.—GRÖNBERG, 1898, Zoolog. Jahrb., Abth. Syst., Bd. 11, pp. 454, 460.—LINKO, 1904, Zool. Anzeiger, Bd. 28, p. 215.

Bell cone-shaped, with a large, conical, apical projection. It is about 25 mm. in height and 20 mm. in diameter. There are 24 to 48 tentacles which are longer than the bell-diameter and which have wide, conical bases. Ocelli (?) The manubrium is quadratic in cross-section and is somewhat longer than wide. The base is wide and cruciform, and the 4 radial corners are wide where the radial-canals enter the stomach. The 4 lips are very prominent and are thrown into complex crenulations and folds. The gonads are composed of about 10 pairs of regularly arranged, simple transverse or oblique ridges across each of the 8 adradial regions of the stomach and are separated in the 4 interradii.

This form is very closely related to *Turris pileata*, with which it may, indeed, prove identical. Haeckel says that it is distinguished from both *T. pileata* and *T. reticulata* by the regular feathered gonads and by the smallness of the 4 funnel-like origins of the radial-canals where they join the stomach. The oral lappets are smaller and less crenulated than in *T. pileata* or *T. reticulata*. The conical, apical projection is half as high as the bell. Color (?)

This species is found off the coast of Greenland. Linko, 1904, also found it in Barents Sea, north of Lapland, and its distribution is, therefore, probably circumpolar in common with other Arctic species of *Turris*.

**Turris campanula.**

*Catablema campanula*, HAECKEL, 1879, Syst. der Medusen, p. 63, taf. 4, fign. 4, 5.—LEVINSEN, 1893, Vid. Meddel. Nat. For. Kjöbenhavn (5), Bd. 4, p. 144.—GRÖNBERG, 1898, Zoolog. Jahrb., Abth. Syst., Bd. 11, p. 460.—LINKO, 1904, Zool. Anzeiger, Bd. 28, p. 215.—BEDOT, 1901, Revue Suisse de Zool., tome 9, p. 482; *Ibid.*, 1905, tome 13, p. 132 (list of references to 1850).

Bell about 20 mm. wide and 20 mm. in height. There is a well-developed, conical, apical projection, which is hollow and contains a prolongation of the gastric cavity. There are 24 to 48 tentacles which are longer than the bell-diameter. Their bases are long and thick. No ocelli. The 4 radial-canals and the circular tube are wide and flat and have numerous complex, or simple, blindly-ending side branches resembling those of *T. eurystoma*. The manubrium is wide and shallow and the 4 lips are thrown into complex crenulations and folds. The 4 gonads are found within 4 crescent-shaped swellings upon the 4 interradial sides of the stomach. A number of simple, straight, longitudinal folds or ridges extend across the crescent-shaped gonad; the horns of each crescent are directed downward, toward the velar opening. The manubrium, gonads, canals, and tentacles are yellow.

This species is found off the coast of Greenland and at Spitzbergen, and Linko found it in Barents Sea, north of Lapland.

**Turris eurystoma.**

*Catablema eurystoma*, HAECKEL, 1879, Syst. der Medusen, p. 64, taf. 4, fign. 6, 7.—LEVINSEN, 1893, Vid. Meddel. Nat. For. Kjöbenhavn (5), Bd. 4, p. 144.—GRÖNBERG, 1898, Zoolog. Jahrb., Abth. Syst., Bd. 11, p. 462.

Bell about 20 to 25 mm. in diameter, and spheroidal, being flatter than it is high. There is a spheroidal, apical projection which varies in size from about one-fourth to almost as large as the bell itself. This apical projection is always solid. The sides of the bell are quite thin. There are about 24 to 48 well-developed tentacles which are much longer than the bell-diameter. These tentacles have long, conical basal bulbs. In addition to the long tentacles there are usually 24 to 32 small, immature, or rudimentary tentacle-bulbs which alternate with the long tentacles. Ocelli (?) There are 4 radial-canals, each of which is about 3 mm. wide in the middle and only 2 mm. wide at either end. Both the radial-canals and the circular

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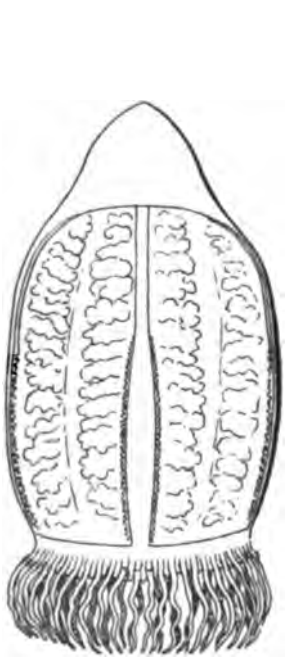
tube give rise to numerous simple or branched, blindly-ending side branches of 0.3 to 1 mm. in length. Some of these side branches are simple sacs, but others give rise to secondary branches. The stomach is wide and cruciform, but the side walls are remarkably short, so that the mouth is a gaping, cruciform slit, reminding one of the mouth-opening of *Stauro-phora*. The 4 interradial sides of the stomach form 4 curtains within which the sperm or ova are developed. The free, lower edges of these curtains are crenulated and thrown into complex folds. The stomach and gonads are cherry-red and the canals and tentacles are light-red in color. This species is found on the coast of Greenland.

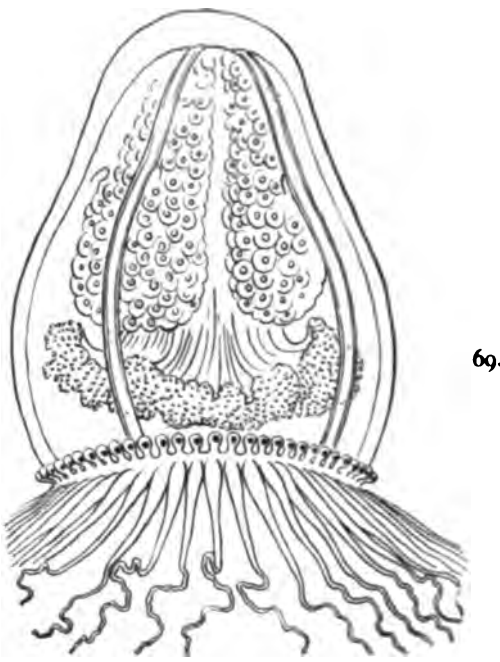
### Turris digitalis Forbes.

*Turris digitalis*, Forbes, 1848, British Naked-eyed Medusæ, p. 21, plate 3, figs. 1*a*–1*e*.—Agassiz, L., 1862, Cont. Nat. Hist U. S., vol. 4, p. 346.—Haeckel, 1879, Syst. der Medusen, p. 61, taf. 4, figs. 2, 3.—Levinsen, 1893, Vid. Meddel. Nat. For. Kjöbenhavn (5), Bd. 4, p. 144.—Krukenberg, 1880, Vergleichend physiolog. Studien zu Turris, etc., Abt. 3, p. 124 (reactions to curare and strychnine).

Bell cylindrical, with a well-developed, conical, apical projection. It is 30 to 40 mm. in height and 15 to 20 mm. in diameter. There are 50 to 100 short tentacles, which appear as if arranged in two rows owing to the fact that the bases of the larger ones extend a slight distance up the sides of the bell above the margin.



68.



69.

Fig. 68.—*Turris digitalis*, after Haeckel, 1879.
Fig. 69.—*Conis cyclophthalma*, after Haeckel, in Syst. der Medusen.

There are 8 strands of longitudinal muscle fibers within the wall of the subumbrella. These strands lie close to, and upon both sides of, the 4 radial-canals. The radial-canals are broad and flat. In its upper half each radial-canal is a simple, flat tube with a straight edge. In their lower halves, however, the canals become broader and give rise to many small side branches which end blindly. The manubrium is very large and fills the greater part of the bell-cavity. The mouth extends to the level of the velar opening. There are 4 prominent crenulated lips. The gonads occupy 4 interradially situated, longitudinal regions upon the wall of the stomach. Each gonad consists of a double row of papilliform ridges, the outer surfaces of which are thrown into complex folds and corrugations.

The stomach is purple or reddish-brown and the lips are rose-colored. The gonads are darker in hue than the stomach. The tentacle-bulbs are orange or yellow and their outer ends are white. The bell is transparent. The 8 muscle-strands in the subumbrella are yellow.

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## Genus CYTÆIS Eschscholtz, 1829.

*Cytæis*, Eschscholtz, 1829, Syst. der Acalephen, p. 104.—Eydoux et Souleyet, 1841, Voyage de la *Bonite*, tome 2, p. 641.—Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, p. 228.— Maas, 1904, Résultats Camp. Sci. Prince de Monaco, fasc. 28, p. 7; 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 8.—Agassiz and Mayer, 1899, Bull. Mus. Comp. Zool. at Harvard College, vol. 32, p. 161.—Browne, 1905, Report Ceylon Pearl Oyster Fisheries, Roy. Soc. London, Supplementary Report 27, p. 135.—Chun, 1895, Bibliotheca Zoologica, Heft 19, p. 11 (law of budding).
*Cytæis+Cubogaster*, Haeckel, 1879, Syst. der Medusen, pp. 73, 75.
*Non Cytæis*, Mayer, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 39.
*Cytæis*, Vanhöffen, 1891, Zool. Anzeiger, Bd. 14, p. 444.
*Non Cytæis*, Sars, 1835, Beskriv og Jagttag., p. 28.
*Cubogaster*, Haeckel, 1864, Jena. Zeit. für Naturw., Bd. 1, p. 341 (young of *Cytæis*).
*Nigritina*, Steenstrup, 1837, Acta et Catal. Musei Hafniensis, Hauniæ.

### GENERIC CHARACTERS.

Margelinæ with 4 simple, radially situated, marginal tentacles and with 4 or more simple, unbranched oral tentacles. The hydroid is unknown.

The type species is *Cytæis tetrastyla* Eschscholtz, 1829, of the Mediterranean and eastern parts of the tropical Atlantic. Eschscholtz states that it has 8 simple oral tentacles and 4 marginal tentacles, but he figures at least 10 oral tentacles. More recently species of *Cytæis* have been found with 8, 16, or even 32 oral tentacles.

*Tabular Synopsis of the Medusæ of Cytæis.*

| | C. tetrastyla Eschscholtz, 1829.* | C. atlantica = C. macrogaster Haeckel, 1879 = C. tetrastyla Eydoux et Souleyet, 1841 = C. nigritina Haeckel, 1879.† | C. pusilla Gegenbaur, 1856. | C. vulgaris Agassiz and Mayer, 1899.† | C. herdmani Browne, 1905. |
|---|---|---|---|---|---|
| Shape and size of bell in mm. | Cubical to domelike. 2 to 3 high, 2 to 3 wide. | Pyriform. 5 high, 6 wi'e. | Oval. 4 high, 3 wide. | Prismatic, flat above. 5 high, 3.5 wide. | Oval. 3.5 high, 3.5 wide. |
| Character of the 4 marginal tentacles. Length in terms of bell-radius ($r$). | Similar each to each. $2r$+ long. Basal bulbs small. | As in C. tetrastyla, but with large pyriform basal swellings on exumbrella above each tentacle. | $2r$+ long. With small basal bulbs. | $2r$ long, with large basal bulbs. | As in C. atlantica. |
| Shape and size of manubrium. | Flask-shaped, mounted on peduncle. Mouth at level of velar opening. | Very large, flask-shaped. Two-thirds to 1.5 times as long as depth of bell-cavity. No peduncle in mature medusa. | Stomach oval. Mounted upon conical peduncle not quite as long as stomach. Mouth at middle of bell-cavity. | Stomach oval to spindle-shape', half to two-thirds as long as depth of bell-cavity. Young medusa has short peduncle, but this is not seen in mature animal. | Wide flask-shaped, on short peduncle. Two-thirds as long as depth of bell-cavity. |
| Number of oral tentacles. | 4 to 6 | 8 to 32 | 12 to 24 | 32 | 50 to 60 |
| Character of gonads and medusa-buds. | 4 interradial swellings. | Numerous medusa-buds on upper half of manubrium. | 4 interradial swellings. | 8 adradial gonads near base, on sides of stomach. | 4 perradial? or 8 adradial? gonads. No medusa-buds. |
| Color. | Stomach and tentacle-bulbs brown. | Stomach yellowish. Gonads and tentacle-bulbs violet-brown, red, or nearly black. | Stomach and gonads yellowish-brown. Tentacle-bulbs black. | Stomach and tentacle-bulbs red and green. Abaxial entoderm red, superficial green. | ? |
| Where found. | Mediterranean, and tropical Atlantic. Canary Islands. | Mediterranean to Atlantic to Brazilian coast. | Mediterranean. | Fiji Islands to Malay Archipelago, tropical Pacific. | Coast of Ceylon. |

*Probably young and immature. Possibly young of *C. atlantica*? †For details see text.

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The gonads of *Cytæis* are developed upon the interradial sides of the stomach. In *Cytæis vulgaris*, according to Maas, 1905, they occur as 4 pairs of slightly swollen, corrugated regions, a pair being found on each interradial side of the stomach. The mature genital products are found in the ectoderm of the stomach-wall. Many of the species develop medusa-buds upon the interradial sides of their stomach. Haeckel's statement that the gonads are radial in position appears to be erroneous.

*Cytæis* is closely related to *Podocoryne* and is distinguished only by its smaller number (4) of marginal tentacles, whereas *Podocoryne* has 8 or more marginal tentacles. Moreover there are commonly more than 4 oral tentacles in *Cytæis*, whereas the majority of the species of *Podocoryne* have only 4 oral tentacles. *Cytæis* is possibly the original genus from which *Podocoryne* and more complex forms may have been derived.

*Cubogaster* Haeckel, 1864, appears to be only the young of *Cytæis*, excepting "*Cubogaster gemmascens*" which I take to be an abnormal young *Rathkea octopunctata* with only 2 well-developed and 6 retarded marginal tentacles. Broch, 1905 (Bergens Museums Aarbog, No. 11, p. 4), states that the marginal tentacle-bulbs may range from 4 to 8, and that well-developed tentacles may be absent.

### Cytæis tetrastyla Eschscholtz.

*Cytæis tetrastyla*, Eschscholtz, 1829, Syst. der Acalephen, p. 104, taf. 8, fig. 2.—Haeckel, 1879, Syst. der Medusen, p. 73.—Bedot, 1905, Revue Suisse de Zool., tome 13, p. 133 (literature, 1829–50).
*Bougainvillea mediterranea*, Busch, 1851, Beobach. wirbell. Seethiere, p. 21, taf. 2, fig. 10.

This medusa is recorded from the Mediterranean and the eastern parts of the tropical Atlantic. For details see tabular synopsis of the medusæ of *Cytæis*.

### Cytæis atlantica.

*Nigritina atlantica*, Steenstrup, 1837, Catal. Musei Hafniensis.
*Cytæis tetrastyla*, Eydoux et Souleyet, 1841, Voyage de la *Bonite*, tome 2, p. 641, plate 2, figs. 4 to 15.
*Cytæis macrogaster*, Haeckel, 1879, Syst. der Medusen, p. 74, taf. 6, fig. 1.—Chun, 1895, Bibliotheca Zoologica, Heft 19, p. 45 (budding of medusæ from the manubrium).
*Cytæis nigritina*, Haeckel, 1879, Syst. der Medusen, p. 74, taf. 6, fign. 2–5.—Maas, 1904, Résult. Camp. Sci. Prince de Monaco, fasc. 28, p. 8, plate 1, figs. 3, 4.

Bell bluntly conical or pear-shaped, about 6 mm. high and 5 mm. wide. There are 4 stout radially placed marginal tentacles longer than the bell-diameter. The bases of these tentacles are very thick and extend up the sides of the bell as large, bulbous, pear-shaped swellings. These swellings bear a large crescent-shaped mass of entodermal pigment on their lower, outer sides. These bulbous swellings are each about one-eighth to one-fourth as high as the bell. The velum is well developed. There are 4 simple, straight radial-canals and a simple ring-canal. The manubrium is large and lacks a peduncle. It is 0.5 to 1.5 times as long as the depth of the bell-cavity. Normally it is probably about as long as the depth of the bell-cavity. There are numerous medusa-buds upon the upper half of the stomach-wall and these are seen in various stages of development. The mouth is surrounded by a circlet of 8 to 32 short, slender, oral tentacles, each of which terminates in a nematocyst-knob. The stomach is reddish-brown and the tentacles brown, with tentacle-bulbs nearly black. This medusa is found in the Mediterranean and Atlantic from the shores of Africa to the Brazilian coast.

Haeckel describes 4 gonads at the points of juncture of the 4 radial-canals with the stomach, but this is probably erroneous, for it is improbable that the gonads are in the principal radii.

Haeckel distinguishes *C. nigritina* with manubrium half as long as the depth of the bell-cavity, and with 16 to 32 oral tentacles; and *C. macrogaster* with manubrium 1.5 times as long as the depth of the bell-cavity and with 8 to 16 oral tentacles. In 1904, Maas describes a very similar medusa, under the name of *C. nigritina*, in which the manubrium is about two-thirds as long as the depth of the bell-cavity and has 11 oral tentacles. These medusæ are so closely similar in all other respects that I am of the opinion that they are merely growth and contraction phases of one and the same species. Following the usual rule of precedence, it appears that the specific name should be "*atlantica*," this being the designation proposed by Steenstrup, 1837.

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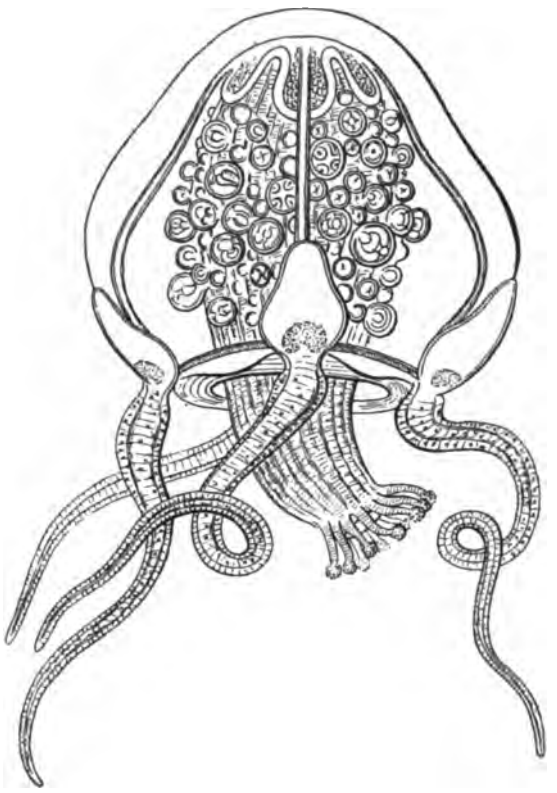
### Cytæis pusilla Gegenbaur.

*Cytæis pusilla*, GEGENBAUR, 1856, Zeit. für wissen. Zool., Bd. 8, p. 228, taf. 8, fig. 8.—KEFERSTEIN UND EHLERS, 1861, Zoolog. Beitrag., p. 84, taf. 13, fign. 8, 9.—HAECKEL, 1879, Syst. der Medusen, p. 75.
(?) *Cubogaster dissonema* (young medusa), HAECKEL, *Ibid.*, p. 76.

This medusa is recorded from the Mediterranean. For details see tabular synopsis of the medusæ of *Cytæis*.

Haeckel describes "*Cubogaster dissonema*" a small medusa 2 mm. high, with 2 well-developed and 2 immature or rudimentary marginal tentacles, and 8 oral tentacles. This he found at Croisic, Bretagne, Atlantic coast of France. It may be the young of *C. pusilla* (?)

71.



73. 72.

FIG. 71.—*Cytæis atlantica*, after Maas, in Résult. Camp. Sci. Prince de Monaco.
FIG. 72.—*Cytæis "macrogaster"* (*C. atlantica*), after Haeckel, 1879.
FIG. 73.—*Cytæis pusilla*, after Gegenbaur, in Zeit. für wissen. Zool., Bd. 8.

### Cytæis vulgaris Agassiz and Mayer.

*Cytæis vulgaris*, AGASSIZ and MAYER, 1899, Bull. Mus. Comp. Zool. at Harvard Coll., vol. 32, p. 161, plate 2, figs. 3–5.—MAAS, 1905, Craspedoten Medusen der *Siboga* Exped., Monog. 10, p. 8, taf. 1, fign. 4–7; 1906, Revue Suisse de Zool., tome 4, p. 85, fig. 3, plate 2.

Mature specimens of this medusa are described by Maas from the Malay Archipelago. Agassiz and Mayer described only half-grown medusæ from the Fiji Islands.

*Mature medusa.*—Bell 5 mm. high, prismatic, 4-sided, and with a flat top. There are 4 thick, radially placed, marginal tentacles, each somewhat shorter than the bell-height. These tentacles end in blunt tips and have large hollow basal bulbs. Maas describes a thick lens-shaped swelling on the abaxial side of each tentacle-bulb, but his specimens are somewhat contracted through preservation in formalin. The basal bulbs of the living medusæ studied by Agassiz and Mayer were large and swollen, but lacked the lenticular, ectodermal swellings. On the other hand Agassiz and Mayer found only half-grown medusæ, and it is possible that the peculiar form of the basal bulbs described by Maas may be characteristic of the full-grown,

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but not of the half-grown, medusa. The velum is well developed. The 4 radial-canals and ring-canal are slender and simple. The manubrium is spindle-shaped and shorter than the depth of the bell-cavity. In the half-grown medusa there is a short conical peduncle, but this was not seen by Maas in his large specimens.

The mouth is at the extremity of a bluntly pointed, conical neck, and is a simple round opening. 32 or more short, slender, filiform, unbranched oral tentacles arise from a zone above the mouth. Each oral tentacle is solid and ends in a knob-like cluster of nematocysts.

The gonads are found on the upper interradial sides of the stomach and appear as a pair of longitudinal swellings in each of the 4 interradii. They are not developed on the 4 radial lines of the stomach. The eggs protrude over the surfaces.

In the *formalin* specimens studied by Maas, the gonads were yellow, the axial entoderm of the stomach dark-red, as were also the entodermal parts of the tentacle-bulbs. There is some green pigment in the ectoderm of the tentacle-bulbs. In the immature specimens from Fiji, studied from life by Dr. Agassiz and his assistant, the entoderm of the outer part of the manubrium and of the tentacle-tips was green, while there was red pigment in the axial part of the stomach and in the tentacle-bulbs and adjacent parts of the 4 radial-canals. In the young specimens from Fiji the oral tentacles ranged from 4 to 16, while in those found by Maas in the Malay Archipelago, they ranged from 8 to 32.

Found in abundance on the surface among the Fiji Islands in November to January. Maas found numerous specimens in the *Siboga* collection from the Malay Archipelago, Sulu, Damar, Daram, Sabuida, Gisser, Manipa Straits, and Saleyer; and from Amboina, 1906.

### Cytæis herdmani Browne.

*Cytæis herdmani*, Browne, 1905, Pearl Oyster Fisheries, Gulf of Manaar, Roy. Soc. London, Suppl. Report 27, p. 135, plate 1, fig. 1; plate 4, fig. 12.

Umbrella about 3.5 mm. in width and height. Somewhat bell-shaped with fairly thick walls. 4 marginal, long tentacles with very large, spear-head-shaped, basal bulbs one-third as long as the bell-height. The ectoderm of the tentacles is thickly crowded with nematocysts. The entoderm of the tentacles and basal bulbs is pigmented. Velum narrow. 4 wide, straight radial-canals. Stomach about as wide as long placed upon a short peduncle and extending a little more than half-way down the cavity of the bell. A row of 50 to 60 short, equally spaced oral tentacles, each ending in a knob of nematocysts. Gonads form 4 (perradial?) swellings extending the entire length of the stomach. Color (?) Coast of Ceylon; Chilaw Paar, and Cheval Paar; March to November.

### Genus PODOCORYNE Sars, 1846.

(?)*Dysmorphosa*, Philippi, 1842, Archiv. für Naturgesch., Jahrg. 8, Bd. 1, p. 37, taf. 1, fig. 3.
*Podocoryne*, Sars, 1846, Fauna littor. Norveg., tome 1, p. 4, taf. 1, figs. 7-18.--Hincks, 1868, British Hydroid Zoophytes, p. 29.—Allman, 1871, Monograph Tubul. Hydroids, p. 348.—Bunting, 1894, Journ. Morphol., vol. 9, p. 205.--Hartlaub, 1905, Zoolog. Jahrbüchern, Supplement 6, p. 523.
*Podocoryna*, Krohn, 1851, Arch. für Naturges., Jahrg. 17, Bd. 1, p. 263.
*Dysmorphosa*, Agassiz, A., 1865, North Amer. Acal., p. 163.—Chun, 1895, Bibliotheca Zool., Heft 19, Lfg. 1, pp. 12, 23.--Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 8. -Vanhoffen, 1891, Zool. Anzeiger, Bd. 14, p. 444.—Bedot, 1905, Revue Suisse de Zool., tome 13, p. 73; *Podocoryne*, *Ibid.*, p. 102 (literature to 1850). Maas, 1906, Revue Suisse de Zool., tome 14, p. 86, plate 3, fig. 8.
*Dysmorphosa*+*Cytæandra*, Haeckel, 1879, Syst. der Medusen, pp. 76, 79.
*Turritopsis*, Agassiz, A., 1865, North Amer. Acal., p. 167.

The name *Dysmorphosa* was first used by Philippi, 1842, in his description of *D. conchicola*, a hydroid polyp which may have been either a *Podocoryne* or a *Hydractinia* in the modern sense. In 1846, Sars described a closely related, medusa-bearing hydroid under the name *Podocoryne carnea*. The name *Dysmorphosa* was first applied to the free medusa by A. Agassiz, 1865. The great majority of authors have included both the hydroid and the free medusa under the generic name *Podocoryne*. In the absence of proof as to whether Philippi's hydroid develops medusæ or not, we are unable to decide with certainty which name should stand, but there is no probability that Philippi's hydroid will ever be determined and we may avoid confusion by considering it obsolete.



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### GENERIC CHARACTERS.

Margelinæ with 4 or more simple, unbranched oral tentacles and with 8 or more simple marginal tentacles. When present the peduncle of the manubrium is simple, solid, and gelatinous. The hydroid stock is *Podocoryne*.

Haeckel, 1879, restricts the genus "*Dysmorphosa*" to include only those medusæ which have 8 marginal tentacles. Medusæ bearing more than 8 tentacles he places in a new genus "*Cytæandra*." Inasmuch as specimens of *Podocoryne fulgurans* and *P. carnea* are often found which have more than 8 tentacles, we consider Haeckel's definitions to be too restrictive. Vanhöffen, 1891, defines *Dysmorphosa*, as we do *Podocoryne*, to include medusa, with 8 or more marginal tentacles.

*Podocoryne* may be distinguished from *Lymnorea* by its simple unbranched oral tentacles. In *Turritopsis* there are no oral tentacles, but only 4 simple lips studded with nematocyst-knobs, and the presence of simple oral tentacles in *Podocoryne* at once distinguishes it from *Turritopsis*. It is distinguished from *Cytæis* by its having *eight or more* marginal tentacles, whereas *Cytæis* is restricted to medusæ bearing 4 marginal tentacles. In *Cytæis* the oral tentacles are commonly more than 4, whereas there are only 3 known species of *Dysmorphosa* bearing more than 4 oral tentacles. *Podocoryne* is possibly derived from the more simply organized *Cytæis*.

### Podocoryne carnea Sars.

Plate 14, figs. 2 to 6; plate 15, fig. 14.

#### SYNONYMS OF THE EUROPEAN FORM.

(?) *Dysmorphosa conchicola*, PHILIPPI, 1842, Archiv. für Naturgesch., Jahrg. 8, Bd. 1, p. 37, taf. 1, fig. 3.
*Podocoryne carnea*, SARS, 1846, Fauna Littor. Norveg., p. 4, taf. 1, figs. 7–18.—KROHN, 1851, Archiv. für Naturgesch., Jahrg. 17, Bd. 1, p. 266.—HINCKS, 1868, British Hydroid Zooph., p. 29, plate 5, 6 figs.—ALLMAN, 1871, Monograph Tubul. Hydroids, p. 349, plate 16, figs. 1–9.—DE VARENNE, 1882, Archiv. de Zool. Expér., tome 10, pp. 645, 674, 683, plate 33, figs. 6–15; plates 34, 36–38; 1882, Compt. rend. Paris, tome 94, p. 892.—WEISMANN, 1883, Sexualzellen bei den Hydromedusen, pp. 63–72, taf. 19, fign. 1–13.—BROWNE, 1896, Proc. Zool. Soc. London, p. 463.—DE VARENNE, 1881, Annals and Mag. Nat. Hist., ser. 5, vol. 9, p. 134.—HAMANN, 1882, Jena. Zeitschrift für Naturwissen., Bd. 15, p. 517, taf. 20, fign. 1, 3, 4 (histology of hydroid).—JICKELI, 1883, Morphol. Jahrb., Bd. 8, p. 621, taf. 27 (histology of the hydroid).—GRAEFFE, 1884, Arbeit. Zool. Inst. Wien, Bd. 5, p. 347.—ISHIKAWA, 1888, Zeit. für wissen. Zool., Bd. 47, p. 621, 6 fign. (origin of egg cells).—BEDOT, 1905, Revue Suisse de Zool., tome 13, p. 103 (literature 1842–1850).—RITCHIE, 1907, Trans. Roy. Soc. Edinburgh, vol. 45, p. 523 (from Cape Colony, South Africa).
*Dysmorphosa carnea*, HAECKEL, 1879, Syst. der Medusen, p. 77.
*Cytæis exigua*, HAECKEL, *Ibid.*, p. 634.
*Podocoryne hæckelii*, HAMANN, 1882, Jena. Zeit. für Naturwissen., Bd. 15, p. 519 (young stocks of *P. carnea* ?).
(?) *Podocoryne conchicola* (Philippi) in part, HARGITT, 1904, Mitth. Zool. Station Neapel, Bd. 16, p. 581, fig. 26, taf. 22.

#### SYNONYMS OF THE AMERICAN REPRESENTATIVE.

*Turritopsis nutricula*, AGASSIZ, A., 1862, Proc. Boston Soc. Nat. Hist., vol. 9, p. 97, figs. 22, 23; 1865, North Amer. Acal., p. 167, figs. 269, 270.—FEWKES, 1881, Bull. Mus. Comp. Zool., vol. 8, p. 153, plate 4, figs. 4, 7–10.
*Calcydion formosum*, FEWKES, 1882, Bull. Mus. Comp. Zool., vol. 9, p. 294.
*Podocoryne carnea*, BUNTING, 1894, Journ. Morphol., vol. 9, p. 205, plate 11, fig. 68.—LEVINSEN, 1893, Vid. Meddel. Nat. For. Kjöbenhavn (5), Bd. 4, p. 153.—HARGITT, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 38, plate 4, fig. 5 (figure labeled "*Turritopsis nutricula*," on p. 37).
*Turritopsis nutricula* (in part), NUTTING, 1901, Bull. U. S. Fish Commission for 1899, vol. 19, p. 375.
*Porocoryne carnea*, HARGITT, 1901, American Naturalist, vol. 35, p. 582, fig. 44.
*Podocoryne*, HAZEN, 1902, Amer. Naturalist, vol. 36, p. 193 (regeneration).

### AMERICAN VARIETY.

*Adult medusa* (plate 15, fig. 14).—Bell ellipsoidal in form and about 3.5 mm. in height. Gelatinous substance not very thick, but quite tough and rigid. There are about 24 to 32 marginal tentacles which are about as long as the bell-height. The tentacles are not very flexible, and are usually carried curled upward. The tentacle-bulbs are well developed and are filled with entodermal pigment granules. The velum is well developed. There are 4 straight and narrow radial-canals. The manubrium is flask-shaped and there is no peduncle. The mouth-opening is surrounded by 4 short, radially situated, unbranched, oral tentacles, each of which terminates in a knob-shaped cluster of nematocysts. The ripe ova and spermatozoa are found in the 4 interradii within the ectoderm of the manubrium. According to Ishikawa and

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## Plate 14.

Fig. 1. *Podocoryne minuta*, Tortugas, Florida, July 16, 1898.

Fig. 2. The hydroid of *Podocoryne carnea*. Agassiz Laboratory, Newport, Rhode Island, June 20, 1895.

Figs. 3 to 5. *Podocoryne carnea*. Stages in the growth of the medusa. Agassiz Laboratory, Newport, Rhode Island, July 20 to 24, 1892.

Fig. 6. *Podocoryne carnea*, young medusa. Agassiz Laboratory Newport, Rhode Island, July, 1895.

Fig. 7. *Podocoryne dubia*.. Tortugas, Florida, July 20, 1898.

Fig. 8. *Podocoryne dubia*. Side view of oral tentacles.

Fig. 9. *Podocoryne dubia*. Side view of marginal tentacles.

Fig. 10. *Turritopsis nutricula*, mature male. Agassiz Laboratory, Newport, Rhode Island, July, 1892.

Figs. 11 to 13. *Turritopsis nutricula*, young stages of the medusa. Agassiz Laboratory, Newport, Rhode Island, July, 1892.

Drawn from life, by the author.

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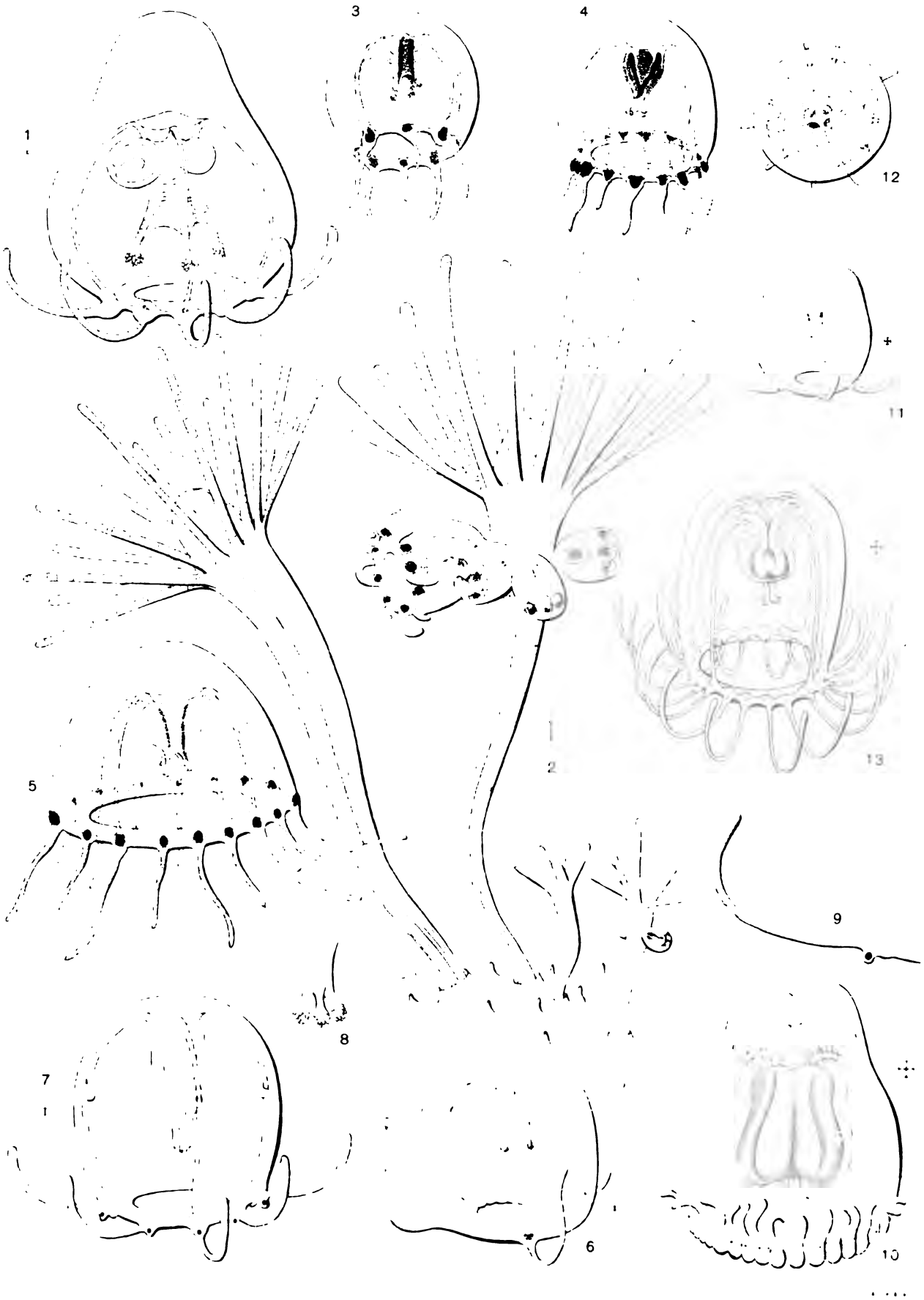


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Bunting, the ova originate in the entoderm, but the sperm originates and remains in the ectoderm. When the medusa is mature both ova and sperm are found in the ectoderm of the stomach. In the female, the ova are large and prominent and are spherical in form. The entoderm of the manubrium and of the tentacle-bulbs is red, or brown to red, in color.

*Hydroid and young medusa.*—No specific difference exists between the American and European hydroid stocks of *Podocoryne*. The hydroid (plate 14, fig. 2) is commonly found upon shells which are tenanted by the hermit-crab (*Pagurus*) and also upon the carapace of *Limulus*. The polypites arise at somewhat irregular intervals from a hydrorhiza which clings to the surface of the shell, etc., upon which the stock is growing. In young colonies the hydrorhiza consists of an open network of anastomosing fibers, which are covered by a thin, delicate perisarc, and externally by a fleshy hydrocaulus, or cœnosarc. As the colony becomes older, however, the fibers of the hydrorhiza form a closer network, and the chitinous perisarc fills in the spaces between them. Numerous short, chitinous spines are developed upon the crust which covers the fibers, and thus we find the polypites arising from a flat, spinous base which adheres to the surface on which the colony is growing. The colony is composed of two kinds of hydranths: sterile feeding-polypites, and reproductive gonostyles. The sterile feeding-polypites are spindle-shaped, being about twice as wide near the oral circlet of tentacles as they are at the base. They have 12 to 16 straight, stiff tentacles. The mouth is situated at the apex of a dome-shaped proboscis. They are very contractile and may vary in length from about 5 to 15 mm. The reproductive polypites, or gonostyles, are frequently exactly similar in size and shape to the feeding-polypites, and, in fact, are probably merely feeding-polypites which have developed medusa-buds (see plate 14, fig. 2, *g*). In other instances the gonostyles are smaller and more slender, and possess not more than 4 to 8 tentacles (see *g'*, fig. 2). The medusa-buds arise from a zone which is slightly below the circlet of oral tentacles. From 4 to 8 of these buds are usually to be seen upon each gonostyle. According to Martha Bunting, 1894, it appears that the medusa-bud arises as an outpushing of both entoderm and ectoderm of the gonostyle. As the bud progresses in its development, we find the ova in the entoderm of the manubrium. When a later stage has been reached they migrate from the entoderm into the ectoderm. The spermatozoa, on the other hand, originate in the ectoderm of the manubrium, as was shown by Weismann, 1883. When set free the medusa usually has 8 tentacles: 4 radial and 4 interradial. The radial tentacles are usually better developed than the interradial and in some individuals there are but 4 tentacles at the time of liberation, the interradial ones not yet being developed.

*Differences between European and American medusæ of Podocoryne carnea.*

| | Podocoryne carnea Sars, of Europe. | Podocoryne carnea var. americana. |
|---|---|---|
| Number of tentacles when liberated from hydroid. | 4 | 4 to 8. Usually 8. |
| Number of tentacles possessed by mature medusa. | Usually 4 to 8, rarely 16 (Graeffe). | 16 to 32. Usually about 24. |
| Medusa-buds on interradial sides of stomach of medusa. | Observed by Sars, 1846. | No medusa-buds observed. |

It is remarkable that while in some stocks of *Podocoryne* the medusæ are set free in an immature state, in others the medusæ are mature when liberated, the manubrium being distended with sperm or ova, which are discharged almost immediately after the medusa is set free. It is possible, as Allman, 1871, suggests, that this difference may be due to the influence of local conditions, which may be favorable in the one case and not so in the other to an advanced development of the medusa. Krohn, 1851, and Loven, 1857, have observed stocks of the European form of *Podocoryne* which were setting free mature medusæ. Indeed, we appear to have a parallel case in *Sarsia* on the Massachusetts coast, where immature medusæ are liberated during the early spring months, whereas the medusæ become ripe, discharge their genital products and wither upon the hydroid stock in May. Good figures of *Podocoryne* stocks which are setting free immature medusæ have been given by Sars, 1846; Hincks, 1868; Allman, 1871; etc. When set free the medusæ commonly have 8 tentacles, 4 radial and 4 interradial. The radial tentacles are usually more advanced than the interradial, and in some few individuals

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there is no trace of interradial tentacles at the time when the medusa is liberated. The manubrium is short and fusiform and the mouth is surrounded by 4 radially situated, oral tentacles, each of which terminates in a knob-shaped cluster of nematocysts. When set free the medusa is about 0.5 to 0.6 mm. in height.

In those medusæ which are set free in an immature condition there are at first 8 tentacles, but these increase in number as growth proceeds and finally, when the medusa is about 3.5 mm. in height, there are usually about 32 tentacles, 8 in each quadrant. The manubrium of the young, immature medusa is slender and fusiform, while in those medusæ which are set free in a

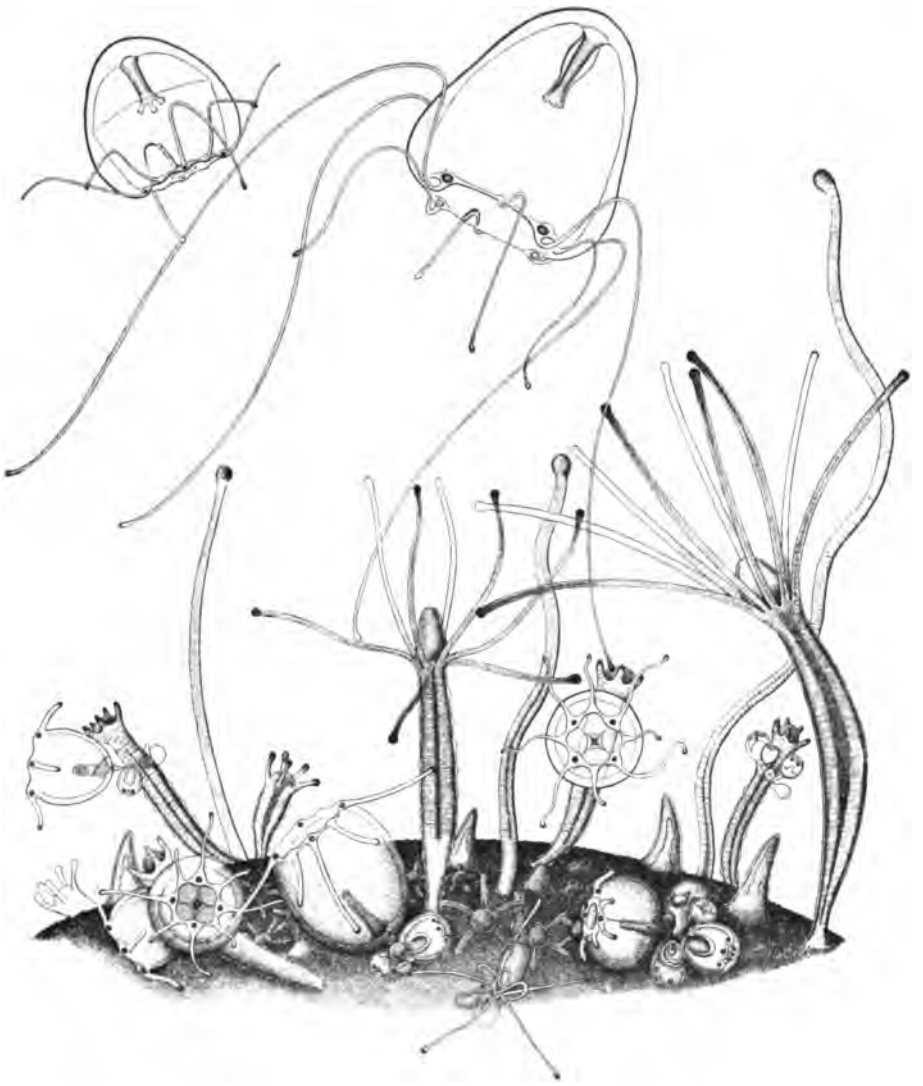

FIG. 74.—*Podocoryne carnea*, hydroid and young medusa. Drawn from life by Professor William K. Brooks, and kindly presented to the author for publication in this work.

mature state it is globular and greatly distended with the genital products. The ectoderm of the hydroid is slightly bluish and translucent, while the entoderm is creamy-pink, or silvery-white in color.

This species has been found upon the Atlantic coasts of Europe, in the Mediterranean Sea, and from Saldanha Bay, Cape Colony, South Africa. Levinsen, 1893, records it from the west coast of Greenland, and we have found it in great abundance in Narragansett and Buzzard's Bays, on the southern coast of New England. It has not been taken at Beaufort, North Carolina, nor at any station farther south. The medusæ are very common in Narragansett Bay from the middle of June until October, and I enjoyed exceptional opportunities

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## Plate 15.

Fig. 1. *Lymnorea borealis*. Eastport, Maine, September 19, 1898.
Fig. 2. *Lymnorea borealis*. Side view of the oral tentacles.
Fig. 3. *Lymnorea borealis*. View of the nematocyst-capsules upon the oral tentacles.
Fig. 4. *Lymnorea alexandri*, young medusa. Nassau Harbor, Bahamas, June, 1903.
Fig. 5. *Lymnorea alexandri*, mature medusa. Nassau Harbor, Bahamas, July, 1903.
Fig. 6. *Lymnorea alexandri*. Cross-section showing the gland-cells of the mid-region of a radial-canal of the medusa shown in figure 5.
Fig. 7. *Lymnorea alexandri*. Knob-like end of one of the oral tentacles showing the nematocysts.
Fig. 8. *Lymnorea alexandri*. Mouth parts of the young medusa shown in figure 4.
Fig. 9. *Lymnorea alexandri*. Marginal tentacle.
Fig. 10. *Turritopsis nutricula*, young medusa. Agassiz Laboratory, Newport, Rhode Island, August, 1892.
Fig. 11. *Turritopsis nutricula*, young medusa. Newport, Rhode Island.
Fig. 12. *Turritopsis nutricula*. View of the lips of a mature male medusa. Tortugas, Florida, April 6, 1906.
Fig. 13. *Turritopsis nutricula*. Aboral view of manubrium showing the vacuolated entodermal cells surrounding radial-canals. Tortugas, Florida, April 6, 1906.
Fig. 14. *Podocoryne carnea*, mature female. Agassiz Laboratory, Newport, Rhode Island, July, 1895.

Drawn from life, by the author.

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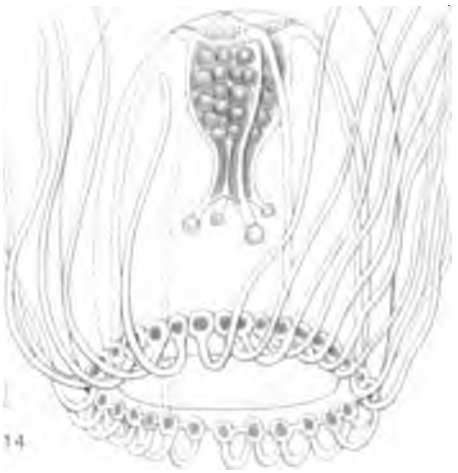
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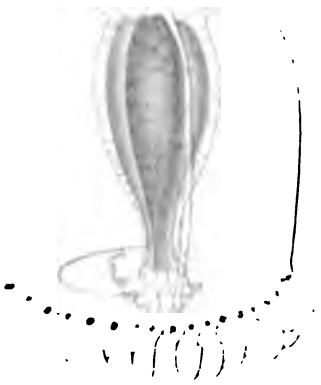
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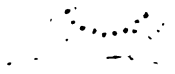
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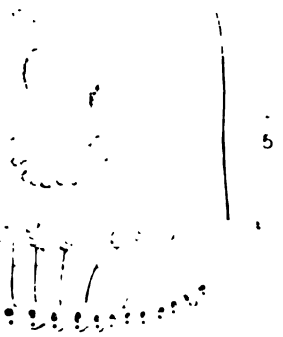
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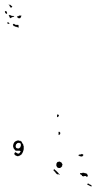
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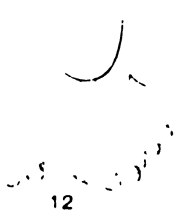
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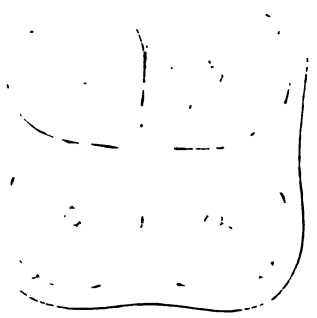
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for observing their growth and development while studying at Dr. Alexander Agassiz's laboratory at Newport, in 1892-96.

In 1881-82 de Varenne concluded that both eggs and sperm-cells originate in the entoderm of the cœnosarc of the hydroid and afterwards migrate into the medusa-bud. The more careful researches of Weismann, 1883, however, refuted this view, showing that the male germ-cells originate in the ectoderm of the budding medusa, but do not wander from their place of origin. On the other hand, the female germ-cells may possibly originate in the ectoderm; if so they soon wander into the entoderm of the budding gonophore, then into the spadix of the medusa-bud and finally into the ectoderm of the manubrium of the medusa. According to the later studies of Ishikawa and of Bunting, however, the egg-cells *originate* in the entoderm of the medusa-bud and afterwards migrate into the ectoderm.

### Podocoryne fulgurans.

Plate 12, figs. 5 to 9; plate 13, figs. 3 to 5.

*Dysmorphosa fulgurans*, AGASSIZ, A., 1865, North Amer. Acal., p. 163, figs. 259, 260.—HAECKEL, 1879, Syst. der Medusen, p. 77.—CHUN, 1895, Bibliotheca Zool., Heft. 19, Lfg. 1, p. 23.—HARGITT, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 38, 1 fig.—NUTTING, 1901, Bull. U. S. Fish Commission, vol. 19, p. 374, fig. 84, A, B.—BROOKS, 1884, Zool. Anzeiger., Jahrg. 7, p. 711 (hydroid?)

(?) *Mabella gracilis*, FEWKES, 1881, Bull. Mus. Comp. Zool. at Harvard College, vol. 8, p. 146.

*Adult medusa.*—Bell usually somewhat pyriform in shape and about 1 mm. in height. Gelatinous substance very soft and flexible, so much so, indeed, that the medusa is often found to be much distorted and shriveled by the powerful contractions of the circular muscles. Very frequently this contraction causes deep interradial furrows to appear upon the surface of the bell, in the meridian of the radiating muscles of the subumbrella, and I believe that this appearance led Fewkes, 1881, to describe one of these contracted medusæ as a new genus: "*Mabella gracilis*." There are usually 8, but sometimes 16 (plate 13, fig. 5), long, marginal tentacles with well-developed basal bulbs. These tentacles are quite stiff and are carried curled upward. The tentacle-bulbs are large and are filled with entodermal pigment. The velum is wide. There are 4 straight, slender, radial tubes. The manubrium is furnished with a well-developed peduncle (plate 12, figs. 6 to 9), which is quadratic in cross-section. The peduncle has the shape of a frustum of a pyramid, and it extends about one-third the distance from the inner apex of the bell-cavity toward the velar opening. The 4 radial tubes extend down the 4 angles of the pyramid into the gastric part of the manubrium. The gastric portion of the manubrium is short and the mouth-opening is situated at the lower extremity of a short tubular neck. There are no prominent lips. 4 radially situated, oral tentacles arise from the sides of the neck. These oral tentacles are quite flexible. They taper gradually and end each in a single, knob-shaped cluster of nematocyst-cells. Medusa-buds are produced upon the sides of the stomach. These buds arise in the interradii (plate 12, fig. 7), and one usually sees 4 or 5 of them in various stages of development. The place and time of appearance of these medusa-buds appear to follow the law demonstrated by Chun, 1895, in *Rathkea octopunctata*. When set free the young medusa has 8 marginal tentacles. It is interesting to observe that while the medusæ are still attached to the manubrium of the mother they themselves begin to develop medusa-buds upon the sides of their manubria (plate 12, fig. 7). The entoderm of the tentacle-bulbs is of a delicate salmon-red. The manubrium is sometimes colorless and sometimes salmon-red.

This medusa is very abundant at Newport, Rhode Island, late in the summer, when it occurs in vast swarms which cause the water, when disturbed at night, to glow with a bluish phosphorescence. A large swarm was found in the St. Mary's River, Maryland, near the mouth of the Potomac, in November, 1905; and I have also taken it at Beaufort, North Carolina, late in November. It has not been seen at Tortugas, Florida.

This species is readily distinguished from *Podocoryne carnea* by its much smaller size. Also the manubrium is provided with a well-developed peduncle, while in *P. carnea* there is no peduncle. *P. fulgurans* is very delicate and flexible, while *P. carnea* is tough and relatively inflexible.

A *Podocoryne* found at Beaufort, North Carolina, by Professor Brooks, is probably the hydroid of this medusa. The tentacles are usually in whorls of 5.

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### Podocoryne areolata Hincks.

*Hydractinia areolata*, ALDER, 1861, Trans. Tyneside Nat. Field Club., vol. 5, p. 225, plate 9, figs. 1–4 (hydroid).
*Podocoryne areolata*, HINCKS, 1868, Hist. British Hydroid Zooph., p. 32, plate 6, fig. 1.
*Cytæandra areolata*, HAECKEL, 1879, Syst. der Medusen, p. 79.
(?) *Cytæandra areolata*, BROWNE, 1895, Trans. Liverpool Biol. Soc., vol. 9, p. 262; 1897, Proc. Zool. Soc. London, p. 817, plate 48, figs. 1–2; 1903, Bergens Museums Aarbog, No. 4, p. 12.

This medusa is liberated from *Podocoryne areolata* of the British coasts.

According to Browne, the medusa becomes about 4 mm. wide and slightly less in height. The bell is pyriform with a thick, gelatinous apex. There are 25 to 30 marginal tentacles about as long as the bell-radius and with fairly large basal bulbs which lack ectodermal ocelli, but have entodermal pigment. The stomach lacks a peduncle and is about one-half to two-thirds as long as the depth of the bell-cavity. There are 4 long, narrow lips, each of which bifurcates and ends in 2 knob-like clusters of nematocysts. The gonads are upon the sides of the stomach.

According to Browne, the entoderm of the stomach and tentacle-bulbs is rich reddish-brown, darker than the stomach.

When set free from the hydroid the medusa has 16 marginal tentacles of various lengths. Browne has not observed the hydroid, which was obtained by Alder. I am inclined to believe that this medusa may prove to be identical with *Lymnorea borealis*, found at Eastport, Maine, on the American Atlantic coast. In Europe it ranges from British coasts to Norway, and is rare according to Browne.

### Podocoryne octostyla.

*Dysmorphosa octostyla*, HAECKEL, 1879, Syst. der Medusen, p. 78, taf. 6, fig. 6.

Bell 0.4 mm. high, 0.5 mm. wide, with bulging sides and low, conical apex. 8 short, equally developed, marginal tentacles, about as long as the radius of the bell, with small basal bulbs. Stomach mounted upon a conical peduncle as long as itself; both together about two-thirds as long as the depth of the bell-cavity. 8 simple, knobbed, oral tentacles about as long as the stomach. 4 swollen, interradial gonads on the sides of the stomach. When young, medusa-buds are produced upon the interradial sides of the stomach. Gonads and tentacle-bulbs nearly black.

Found in the Mediterranean. Two specimens were found by Haeckel.

### Podocoryne polystyla.

*Cytæandra polystyla*, HAECKEL, 1879, Syst. der Medusen, p. 79.

Bell nearly cubical, 1.5 mm. wide, 1.5 mm. high. 32 short, marginal tentacles (without ectodermal ocelli?). Stomach large, cubical, mounted on a short peduncle and filling nearly all of the bell-cavity. 16 short, simple, oral tentacles. 4 gonads on the lower part of the stomach-wall. The gonads are "half-moon-shaped" with the convex side below. Stomach yellow. Gonads and tentacle-bulbs reddish-brown.

Found by Haeckel at Croisic, Atlantic coast of France.

### Podocoryne minuta.

Plate 14, fig. 1.

*Dismorphosa minuta*, MAYER, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 41, plate 18, fig. 42.
*Dysmorphosa minuta*, TRINCI, 1904, Monit. Zool. Ital., Anno 15, p. 304.
(?) *Cytæis minima*, TRINCI, 1903, Mittheil. Zool. Sta. Neapel, Bd. 16, p. 1, taf. 1, fign. 1–30 (young medusa?).

Bell pear-shaped and only 0.3 mm. high. Bell-walls quite thick and the apex solid and bluntly pointed. In common with other species of *Podocoryne*, the gelatinous substance of the bell is very delicate and the medusa soon collapses into a shapeless mass when subjected to the abnormal conditions of captivity in a small aquarium. There are 8 solid, marginal tentacles with well-developed basal bulbs without ocelli. The velum is narrow. There are 4 straight, narrow radial-canals and a slender ring-canal. The manubrium is mounted upon a short, wide peduncle, which is solid, and down the 4 radial corners of which the radial-canals extend into the stomach. The gastric portion of the manubrium is 4-sided in cross-section. 4 well-developed, oral tentacles surround the mouth. The entodermal cores of these oral tentacles are composed of chordate cells, and each tentacle terminates in a bristling,

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## Plate 16.

Figs. 1 to 3. *Podocoryne gracilis.* Successive stages in the growth of the medusa. Tortugas, Florida, June, 1899.

Figs. 4 to 5. *Bougainvillia autumnalis*, young and mature stages of the medusa. Agassiz Laboratory, Newport, Rhode Island, September, 1895 and July, 1896.

Fig. 6. *Bougainvillia frondosa*, showing planulæ upon the sides of the stomach. Tortugas, Florida, June, 1897.

Fig. 7. *Bougainvillia carolinensis*, young medusa. Agassiz Laboratory, Newport, Rhode Island, July, 1892.

Fig. 8. *Bougainvillia carolinensis.* Cluster of marginal tentacles of a young medusa from Newport, Rhode Island.

Fig. 9. *Bougainvillia carolinensis.* Oral tentacle of a young medusa from Newport, Rhode Island.

Drawn from life, by the author.

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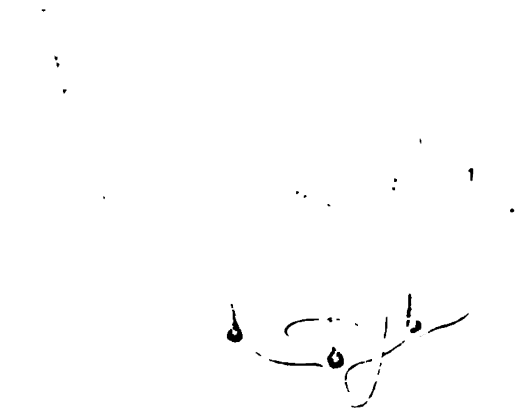
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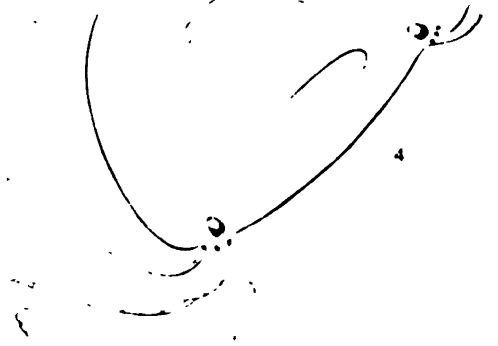
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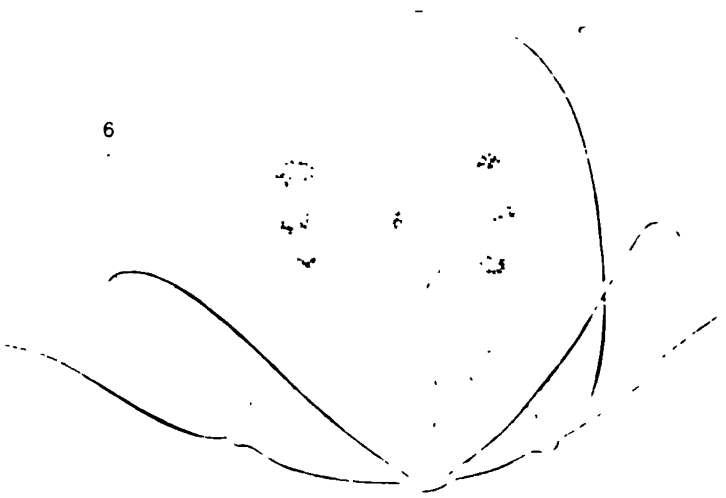
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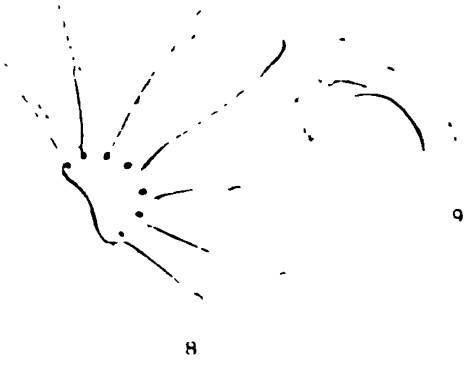
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knob-like cluster of nematocysts. Several medusa-buds in various stages of development are found upon the sides of the upper interradial regions of the stomach. These budded medusæ are set free as in *P. fulgurans*.

In some specimens the entoderm of the manubrium and tentacle-bulbs is turquoise-blue and in others it is lilac.

This medusa was abundant at Tortugas, Florida, in the middle of July, 1898, and Trinci finds a very similar medusa at Naples, Italy. I am inclined to regard Trinci's *Cytæis minima* as the immature, 4-tentacled, medusa-budding stage of *Podocoryne minuta*. According to Trinci the bell is pyriform, 0.27 to 0.33 mm. high and 0.2 to 0.24 mm. wide. 4 perradial, marginal tentacles, each as long as the bell-diameter, with well-developed basal bulbs without ectodermal ocelli. Manubrium and tentacles yellowish-brown with blue in the entoderm. Medusa-buds develop upon the 4 interradial sides of the manubrium. These budding medusæ are formed *entirely* from the ectoderm of the parent medusa.

Trinci in the following year found a medusa similar to the above, but with 8 marginal tentacles. Excepting for a slight color difference this 8-tentacled medusa is identical with *P. minuta* from Tortugas, Florida.

### Podocoryne tenuis.

*Dysmorphosa tenuis*, BROWNE, 1902, Annals and Mag. Nat. Hist., ser. 7, vol. 9, p. 277.
(? ?) *Podocoryne humilis* (hydroid), HARTLAUB, 1905, Zoolog. Jahrbüchern, Suppl. 6, p. 523, fig. 1.

Umbrella somewhat conical, 2 mm. high and 1.5 wide. There is a slight constriction above the level of the subumbrella cavity. 8 tentacles. Manubrium cubical and mounted upon a peduncle about as long as itself. Mouth with 4 lips having terminal clusters of nematocysts. Medusa-buds are found upon the interradial sides of the manubrium. Gonads not developed in the two specimens studied by Browne. Color (?)

Found at Stanley Harbor, Falkland Islands. Briefly described without figures by Browne. This medusa appears to differ widely from the North American variety of *Podocoryne carnea*, but the hydroid described by Hartlaub bears a close resemblance to our North American *P. carnea*. Hartlaub's hydroid may not be the stock of *P. tenuis*, however.

### Podocoryne dubia Mayer.

Plate 14, figs. 7 to 9.

*Dysmorphosa dubia*, MAYER, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 40, plate 22, figs. 64-66.

Bell higher than a hemisphere, 1.5 mm. high and three-fourths-egg-shaped, with thin, uniform, flexible walls. There are 8 stiff, marginal tentacles which are club-shaped, being somewhat wider near their ends than they are near their basal bulbs. The outer extremities of the tentacles are thickly covered with nematocysts. Their basal bulbs are large and swollen, and a very large, black ocellus is found in the ectoderm of the under side of each bulb (plate 14, fig. 9). The velum is well-developed. There are 4 straight, narrow radial-canals and a ring-canal. At the middle point in the length of each radial-canal there is a small, hernia-like swelling, which is probably glandular and similar in structure to the swollen parts of the radial-canals of *Lymnorea alexandri*.

The manubrium is pear-shaped, quite slender, and extends about half the distance from the inner apex of the bell-cavity to the velar opening. The mouth is surrounded by 4 short, radially situated, oral tentacles, each of which terminates in a bristling cluster of nematocysts (plate 14, fig. 8). Gonads (?) The entoderm of the manubrium and tentacle-bulbs is delicate custard-yellow. Only one specimen has been found. This was taken on the surface at Tortugas, Florida, on July 20, 1898.

### Podocoryne gracilis.

Plate 16, figs. 1 to 3.

*Cytæis gracilis*, MAYER, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 39, plate 36, figs. 122 124.
*Dysmorphosa gracilis*, MAAS, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 8.

*Mature medusa.*—Bell pyriform or dome-like with a slight apical projection. It is about 3 mm. in diameter and a little broader than it is high. The gelatinous substance is of only moderate thickness on the sides, although it is about twice this thickness at the apex of the

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bell. There are 8 stiff marginal tentacles with large basal bulbs. These tentacles are carried curled upward from the bell-margin. The 4 radially situated, marginal tentacles are about two-thirds as long as the bell-height, but the 4 interradial ones are only about half of this length. The basal bulbs of all of the tentacles are large, swollen, and hollow, with their entoderm deeply pigmented. The velum is broad. There are 4 simple, straight radial-canals and a simple circular vessel. The stomach is mounted upon a short, wide, solid peduncle. The stomach and mouth-parts are together only about half as long as the depth of the bell-cavity. The mouth is a simple, round opening without prominent lips and is surrounded by 8 unbranched, oral tentacles, each of which terminates in a knob-like bristle of nematocysts. 4 of these oral tentacles are radial and 4 interradial in position. Their entodermal cells are chordate, and the nematocyst-capsules upon their free ends are spindle-shaped. Medusa-buds develop upon the 4 interradial sides of the stomach. When set free each medusa has only 4 short, equally developed, marginal tentacles. The 4 interradial, marginal tentacles do not develop until the medusa is about half-grown and after it has acquired 8 oral tentacles. The entoderm of the manubrium is usually red in color, although often the inner core is red or pink and the outer annulus of entoderm is green. Each tentacle-bulb is provided with a dense mass of red, entodermal pigment, which in the case of the radial tentacle-bulbs extends a considerable distance up the radial-canals. This medusa was quite common on the surface at Tortugas, Florida, in June, 1899 and 1907.

This species and *P. octostyla* Haeckel are the only forms of *Podocoryne* having more than 4 oral tentacles. The remarkably late development of the 4 interradial, marginal tentacles and the presence of more than 4 oral tentacles indicate the close relationship between *Cytæis* and *Podocoryne*. In *Cytæis* more than 4 oral tentacles are the rule. Although the medusa appears to begin life with but 4, later it acquires 8 or more, *Cytæis vulgaris* having 32 tentacles.

**Podocoryne humilis Hartlaub.**

*Podocoryne humilis*, HARTLAUB, 1905, Zoolog. Jahrbüchern, Suppl. 6, p. 523, fig. E.
(?) *Dysmorphosa tenuis* (medusa), BROWNE, 1902, Annal. and Mag. Nat. Hist., ser. 7, vol. 9, p. 277.

Hartlaub describes this hydroid from Terra del Fuego, and states that it may prove to be the stock of *Podocoryne tenuis*, which was briefly described by Browne, 1902, from the Falkland Islands.

The polypites arise in groups from the hydrorhiza. The feeding polypites are about 1 mm. long, club-shaped, with narrow bases, and a short, conical hypostome, which is encircled by a single zone of about 12 filiform tentacles about half as long as the body of the polypite.

The reproductive polypites are swollen, with only about 5 well-developed tentacles with a cylindrical proboscis, and with 3 to 4 large medusa-buds upon the basal half of the polypite below the zone of tentacles. These medusa-buds are mounted upon short pedicles, and when set free the medusæ have no sexual products. The hydrorhiza forms an open network of thin branches bearing short, smooth, thorn-like processes. There are no spiral zooids or tentacular filaments. Color (?) Number of tentacles possessed by the medusa when set free?

Puerto Bridges, southern Terra del Fuego, January, 1893; from a depth of 7 fathoms.

This species appears to me to be closely allied to, if not identical with, the *Podocoryne* of the coast of New England. The number of the tentacles is very variable in our New England *Podocoryne*, especially in the reproductive polypites, and the colonies range considerably in size, apparently being influenced in this respect by conditions of nutrition. There is nothing in Hartlaub's description to prevent our considering the species from the southern end of South America to be identical with *P. carnea* of the coast of New England.

**Podocoryne denhami Thornely.**

*Podocoryne denhami*, THORNELY, 1905, Roy. Soc. Report Ceylon Pearl Oyster Fisheries, vol. 2, p. 110, plate 1, fig. 6.

Basal crust beset with numerous tall, stout, linear, reddish spines. Hydranths white, with about 24 tentacles on the barren ones, and only 4 or 5 on those bearing gonophores; and these latter are considerably swollen. A pair of large globule (medusiform?) gonophores on each reproductive hydranth. Medusa unknown. Size (?)

Growing on a shell of *Murex* in Polk Strait, Ceylon.

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### Genus TURRITOPSIS McCrady, 1856.

*Oceania* (*Turritopsis*), McCrady, 1856, Proc. Elliott Soc. Charleston, p. 1.
*Modeeria*, Fewkes, 1881, Bull. Mus. Comp. Zool., vol. 8, p. 149.
*Turritopsis*, McCrady, 1857, Gymn. Charleston Harbor, p. 24.—Haeckel, 1879, Syst. der Medusen, p. 65. Brooks, 1883, Studies Biol. Lab. Johns Hopkins Univ., vol. 2, p. 465.—Brooks, 1886, Mem. Boston Soc. Nat. Hist., vol. 3, p. 387.—Hartlaub, 1897, Meeresuntersuch., Helgoland, Neue Folge, Bd. 2, Heft. 1, Abt. 2, p. 480.—Vanhoffen, 1891, Zool. Anzeiger, Bd. 14, p. 444.—Brooks and Rittenhouse, 1907, Proc. Boston Soc. Nat. Hist., vol. 33, p. 436.
*Non Turritopsis*, Agassiz, A., 1865, North Amer. Acal., p. 167.

The type species of this genus is *T. nutricula* McCrady, 1856-57, from Charleston Harbor, South Carolina. It is common in summer from the West Indies to the southern coast of New England.

#### GENERIC CHARACTERS.

Margelinæ with 8 or more simple, marginal tentacles, which arise singly, not in clusters, from the bell-margin. The walls of the 4 radial-canals, above the stomach, consist of highly-vacuolated, entodermal cells, forming a peduncle for the gastric part of the manubrium. The 4 lips are studded with nematocyst-bearing knobs. The gonads are developed upon the 4 interradial sides of the stomach. The hydroid is *Dendroclava*.

*Turritopsis* is peculiar in the remarkable development of vacuolated, entodermal cells lining the courses of the 4 radial-canals above the stomach. This condition is also displayed to a limited degree by some, but not by all, of the medusæ of the genus *Lymnorea*. In *Lymnorea*, however, the mouth is surrounded by branched, oral tentacles, whereas in *Turritopsis* the lips display bead-like knobs of nematocysts, which I am inclined to regard as the remnants of the oral tentacles of the ancestral forms of *Turritopsis*. The tentacles of *Turritopsis* are solid and similar in structure to those of *Lymnorea*. There is an ectodermal ocellus upon the inner (axial) side of each tentacle, adjacent to the basal bulb. In Tiarinæ, on the other hand, when ocelli are present they are found upon the outer (abaxial) sides of the tentacle-bulbs. On account of the close similarity between the tentacles of *Turritopsis* and those of *Oceania*, *Lymnorea*, *Podocoryne*, *Cytæis*, and *Cubogaster*, we incline to Vanhöffen's (1891) view that *Turritopsis* is related to the Margelinæ rather than to the Tiarinæ.

*Turritopsis* is closely related to *Oceania*, but is distinguished by its vacuolated peduncle, that of *Oceania* being solid and gelatinous.

### Turritopsis nutricula McCrady.

Plates 14 and 15, figs. 10 to 13.

*Oceania* (*Turritopsis*) *nutricula*, McCrady, 1856, Proc. Elliott Soc. Charleston, pp. 1-36, plate 4, figs. 1-10.
*Turritopsis nutricula*, McCrady, 1857, Gymn. Charleston Harbor, p. 25, plate 8, fig. 1.—Brooks, 1883, Studies Johns Hopkins Univ. Biol. Lab., vol. 2, p. 465.—Brooks, 1886, Mem. Boston Soc. Nat. Hist., vol. 3 p. 388, plate 37.—Haigitt, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 37 (the figure is *Podocoryne carnea*).—Rittenhouse, 1907, Proc. Boston Soc. Nat. Hist., vol. 33, p. 437, plates 30-35, figs. 1-55 (development).
*Modeeria multitentacula*, Fewkes, 1881, Bull. Mus. Comp. Zool. at Harvard College, vol. 8, p. 149, plate 3, figs. 7-9.
*Modeeria nutricula*, Fewkes, 1882, Bull. Mus. Comp. Zool., vol. 9, p. 295.
*non Turritopsis nutricula*, Agassiz, A., 1865, North Amer. Acal., p. 167, figs. 269, 270.
*Turritopsis nutricula* (in part), Haeckel, 1879, Syst. der Medusen, p. 66.—Nutting, 1901, Bull. U. S. Fish Commission, vol. 19, p. 375.

#### European Medusa.

*Oceania polycirrha*, Keferstein, 1862, Zeit. für wissen. Zool., Bd. 12, p. 26, taf. 2, fign. 11-13.
*Turritopsis polynema*, Haeckel, 1879, Syst. der Medusen, p. 66.
*Turritopsis polycirrha*, Hartlaub, 1897, Wissen. Meeresuntersuch. Kommis., Meere Kiel, Helgoland, Neue Folge, Bd. 2, p. 480, taf. 16c, fig. 2.
(?) *Cytæis polystyla*, Will, 1844, Horæ Tergestinæ, p. 68, taf. 2, fig. v.

*American medusa* (plate 14, fig. 10).—Bell usually slightly pyriform and about 4 to 5 mm. in height. Bell-walls uniformly thin. There are 40 to 70 simple, marginal tentacles, which are all of about the same length and are somewhat shorter than the bell-height. These tentacles are capable of much contraction or extension. Their basal bulbs are large and there is a single, ectodermal pigment-spot upon the lower (centripetal) side of each tentacle near its place of origin from the basal bulb. The surface of the tentacles is covered thickly with nematocyst-cells. The velum is well developed. There are 4 straight, narrow radial-canals and a narrow circular vessel. The manubrium is large and fills about half of the bell-cavity. The upper

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part of the manubrium near the base consists of 4 radially situated masses of large, highly vacuolated, entodermal cells, through the midst of which the 4 radial-canals extend downward into the stomach. These cells are indeed only the entodermal walls of the radial-canals (plate 14, fig. 13). The stomach is large and quadratic in cross-section. The cruciform mouth is situated at the extremity of a short neck and is surrounded by a row of nematocyst-bearing knobs (plate 15, fig. 12). The gonads are developed upon the sides of the stomach, where they occur in the form of a double, longitudinal, swollen region in each adradius. Their outer surfaces are smooth. The entoderm of the stomach is dull-yellow or orange, or dull-yellow streaked with orange. The tentacle-bulbs sometimes contain a little entodermal orange pigment. The ocelli upon the tentacles are dark-brown or orange.

*Hydroid and young medusa.*—The hydroid (fig. 76) was found by Brooks, 1883, on piles of a wharf at Morehead City, North Carolina. It is a *Dendroclava* and closely related to *D. dohrnii* Weismann. The stems of the hydroid are from 8 to 10 mm. in height and bear large, terminal hydranths. There are also numbers of short, side branches which terminate in hydranths. The main stem and the side branches are incased in a loose, cylindrical perisarc, which is thick and becomes incrusted with foreign matter. The perisarc is not annulated, and terminates abruptly by a sharp collar immediately below each hydranth. The hydranth or feeding-polypite is long and fusiform and bears from 18 to 20 short, thick, filiform tentacles, which are arranged in three or more indefinite rows or whorls. The medusa-buds originate upon the sides of the stem at the bases of the hydranths. Each medusa-bud is borne upon a short stalk or peduncle and is closely invested by a thin capsule of perisarc. When set free the young medusa has 8 tentacles. The manubrium is cone-shaped and there is a large peduncle formed of highly-vacuolated cells. 4 prominent, nematocyst bearing knobs surround the mouth. The hydranths are pale yellowish-red.

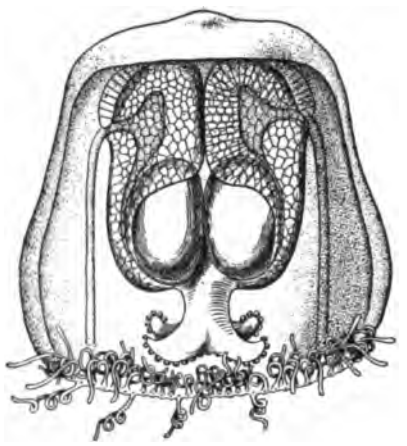

FIG. 75.—*Turritopsis nutricula*, after Brooks, in Mem. Boston Soc. Natural History.

This medusa is found from the coast of Cuba to the southern coast of New England, being about equally abundant in the northern and southern limits of its range. It is very common in the Bahamas and at Tortugas, Florida. In Charleston Harbor, South Carolina, it is commonly infested by larvæ of *Cunoctantha octonaria* McCrady, although it appears to be quite immune from this parasite in other places. I can detect no specific distinctions between this medusa and "*Turritopsis polycirrha*," which is occasionally seen off the Atlantic coast of France and Germany. This form is well figured by Keferstein, 1862, and Hartlaub, 1897, who are the only European students who have observed the medusa on the eastern side of the Atlantic.

Rittenhouse, 1907, has made an elaborate study of the development of *T. nutricula*. The ova develop in the ectoderm of the 4 interradial sides of the manubrium. The primitive ova grow by the absorption of ovarian cells around them, as is common in other hydromedusæ. The yolk-spheres in the ovum are formed from the ovarian cells which it absorbs. About 20 to 35, rarely 50 or more, eggs are discharged into the water by the muscular rupture of the ovarian walls between 5 and 6 o'clock in the morning. The discharged eggs are spherical, 0.116 mm. in diameter and have no membrane. They are yellowish-white, heavier than sea-water, and opaque. The outer layer of finely-granular ectoplasm is distinct from the coarsely granular, yolk-laden endoplasm. Soon after being discharged the egg gives off two polar bodies and is fertilized. Segmentation is total and approximately equal. The first two segmentation planes are meridional and the third equatorial. The blastomeres remain quite far apart, touching only slightly. After this the cleavage becomes remarkably irregular, recalling the extraordinary condition observed by Hargitt in *Pennaria*. A solid morula is formed, which has no central segmentation cavity and which resembles a loosely-connected mass of irregularly grouped cells rather than an embryo of any metazoan. The cleavages follow one after another at intervals of 20 to 30 minutes.

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As in Metschnikoff's *Oceania armata* and Hargitt's embryos of *Pennaria*, this irregularly shaped morula gradually changes into an oval embryo, the surface of which becomes ciliated, so that it swims upward from the bottom. This takes place at about 4 in the afternoon in eggs which were laid between 5 and 6 in the morning.

Rittenhouse finds that during this period, when the loose, irregularly shaped mass of cells shapes itself into an oval embryo, the ectoderm and entoderm are formed? During this period "the cell-boundaries are lost for a short time and a syncytium is formed. This syncytial structure is crowded with yolk-granules and nuclei are scattered throughout the protoplasm. The nuclei soon become more numerous near the periphery and the cell-walls begin to appear"

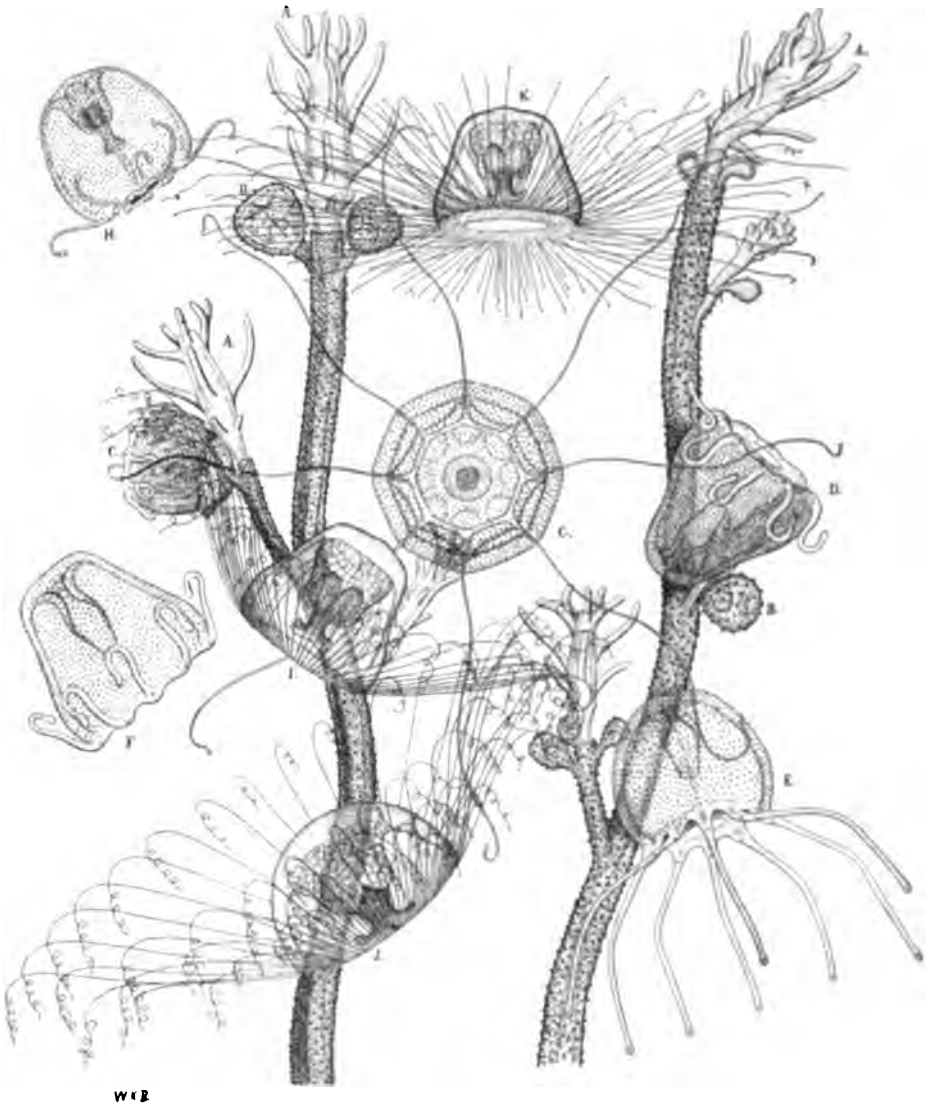

FIG. 76. *Turritopsis nutricula*, after Brooks, in Mem. Boston Soc. Nat. Hist. Hydroid and young medusa.

between the peripheral nuclei. These peripheral cells are to become the ectoderm, which is soon separated from the inner, structureless mass by the development of the mesoglœa. This inner mass afterwards acquires cell-boundaries between its nuclei, and still later a central cavity, the cœlenteric space, develops; and thus the entoderm is formed. This cœlenteric cavity does not develop, however, until the larva is 48 to 60 hours old. The syncytium condition in *Turritopsis* is much more complete than is seen according to Hargitt in *Pennaria*, or in *Bougainvillia*, according to Gerd, 1892.



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Rittenhouse finds that during the early stages of cell-division in *Turritopsis* the multiplication is solely by mitosis, but that later, when the embryo becomes a mere irregularly arranged mass of loosely-compacted cells, some of the nuclei divide amitotically.

When about 50 hours old the elongate, oval larva ceases to swim through the water and settles down upon its side on the bottom. The larva then becomes the hydrorhiza, or root, of the hydroid, and the first hydranth arises as a bud from about the middle of its length. The tentacles of the hydranth develop in indefinite whorls, with 4 tentacles in each whorl, the oldest tentacle being nearest to the mouth. In the mature hydroid the tentacles appear to be irregularly scattered rather than being arranged in whorls.

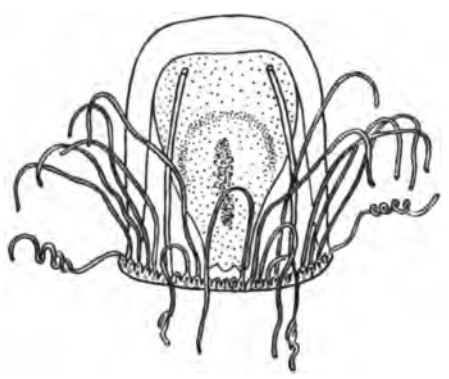

FIG. 77.—*Turritopsis*, sp. (?)=(*Oceania polycirrha*), after Keferstein, 1862, Zeit. für wissen. Zool., Bd. 12, taf. 12, fig. 11.

*Turritopsis* should be reared under more natural conditions than those of the ordinary laboratory in order to determine whether the remarkable, irregularly formed embryos described by Rittenhouse be normal or merely the result of pathological states induced by adverse conditions; but Miss Beckwith has recently shown that the cleavage of *Pennaria* is normally irregular as is described by Hargitt.

Rittenhouse finds that when the embryo is in the loose-celled, morula stage it may be divided into two masses, each one of which produces a normal planula larva of small size.

### Turritopsis (?) lata von Lendenfeld.

*Turritopsis lata*, VON LENDENFELD, 1884, Proc. Linnean Soc. New South Wales, vol. 9, p. 588, plate 22, figs. 36, 36*a*.
(??) *Melicerta pleurostoma*, PÉRON ET LESUEUR, 1809, Ann. du Mus. Hist. Nat., Paris, tome 14, p. 353.

*Mature medusa*.—Bell 3.5 mm. high, 3 mm. wide, with a low, dome-like, apical projection. 60 to 130 marginal tentacles about as long as the bell-height. These have well-developed basal bulbs, and there is an ocellus on the inner (velar) side of the base of each tentacle. Velum well developed. 4 broad, straight radial-canals. The manubrium is mounted upon a peduncle, but von Lendenfeld does not state whether it be composed of vacuolated, entodermal cells or of the gelatinous substance of the bell, and his figures are too vague to throw any light upon this point. Until this is settled we can not determine the systematic position of this medusa. The stomach is spindle-shaped, about two-thirds as long as bell-height. The mouth does not extend to the velar opening, and there are 4 lancet-shaped lips which are recurved and one-third as long as the manubrium. These lips have stalked nettling warts on their margins. There are 4 protruding gonads on the stomach-wall, each one being one-fourth spherical in shape. Gonads and entoderm of tentacle-bulbs intensely brown. Ocelli red.

This is the most abundant medusa in Port Jackson, New South Wales, during the Australian summer and autumn.

The young medusæ have but 4 marginal tentacles.

### Genus OCEANIA, sens. Kölliker, Gegenbaur.

*Oceania* (in part), PÉRON ET LESUEUR, 1809, Annal. du Mus. Hist. Nat. Paris, tome 14, pp. 344-347.
*Oceania*, KÖLLIKER, 1853, Zeit. für wissen. Zool., Bd. 4, p. 323.—GEGENBAUR, 1856, Zeit. für wissen. Zool., Bd. 8, p. 223.—KEFERSTEIN UND EHLERS, 1861, Zool. Beitr. Messina, p. 83.—METSCHNIKOFF, 1886, Embryol. Studien an Medusen, Wien, pp. 23, 25, etc., to 78.
*Turritopsis* (in part), HAECKEL, 1879, Syst. der Medusen, p. 65.
(?) *Modeeria* (young medusa), FORBES, 1848, British Naked-eyed Medusæ, p. 70.
*Modeeria*+*Callitiara*, HAECKEL, 1879, Syst. der Medusen, pp. 47, 48.
*Oceania*=*Callitiara*, VANHÖFFEN, 1892, Verhandl. Gesell. Deutsch. Naturf. Arzte, 64 Vers., Abth. Syst., p. 121.

The generic name "*Oceania*" of Péron and Lesueur has no definite modern meaning, for it was applied to many medusæ belonging to the Eucopidæ, Tiarinæ, Thaumantidæ, etc. In 1862 "*Oceania*" was restricted by L. Agassiz to apply to a genus of the Eucopidæ, but this same genus had already been named *Phialidium* by Leuckart, 1856, and thus Agassiz's

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genus *Oceania* loses precedence. The type species of *Oceania* in the modern sense is *O. armata* of the Mediterranean. It is possible that one of Péron and Lesueur's descriptions refers to this medusa (i. e., *Oceania flavidula?*), but I am in much doubt upon this point. We must fall back upon Kölliker, 1853, and Gegenbaur, 1856, for the definition of *Oceania* in the modern sense.

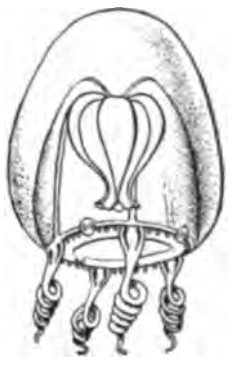
Haeckel suppresses *Oceania* and merges it with *Turritopsis*, but in *Oceania* the peduncle is simple, solid, and gelatinous, whereas in McCrady's *Turritopsis* it is composed of large, vacuolated cells.

### GENERIC CHARACTERS.

Margelinæ with 8 or more marginal tentacles which arise singly from the bell-margin, and are not grouped in isolated clusters. There are ectodermal ocelli on the inner (velar) sides of the tentacle-bulbs. The manubrium is mounted upon a simple, solid, gelatinous peduncle. The 4 lips lack oral tentacles, but their margins are lined by a row of wart-like nematocysts. The hydroid is clava-like.

Following the lead of Agassiz, it has been the custom of American students to define *Oceania* in a sense equivalent to *Phialidium* of Leuckart, but as we have seen *Phialidium*, 1856, clearly takes precedence over Agassiz's *Oceania*, 1862.

In the system here proposed the genus *Oceania* falls among the Oceanidæ instead of being among the Eucopidæ as it would be were Agassiz's definition admissible.



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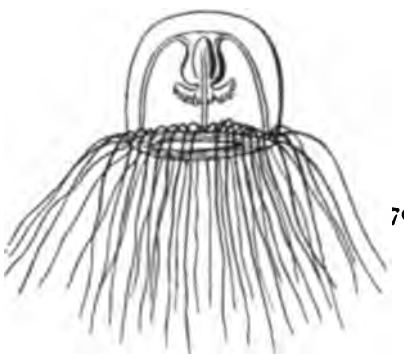

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FIG. 78.—"*Modeeria formosa*," after Forbes.
FIG. 79.—*Oceania* "*flavidula*" (*O. armata*), after Gegenbaur, in Zeit. fur wissen. Zool., Bd. 8.

The generic name *Modeeria* Forbes, 1848, was applied to a very young and immature medusa which is so vaguely described that we can not state whether or not it had ectodermal ocelli. I consider that the name *Modeeria* had best be dropped, having already led to nearly endless confusion.

The genus *Oceania* is closely related to *Turritopsis*, but is distinguished by its simple, solid, gelatinous peduncle; whereas the peduncle in *Turritopsis* is composed of a mass of vacuolated entodermal cells.

### Oceania armata Kölliker.

(?) *Modeeria formosa* (young medusa), FORBES, 1848, British Naked-eyed Medusæ, p. 70, plate 7, fig. 1.
*Oceania armata*, KOLLIKER, 1853, Zeit. fur wissen. Zool., Bd. 4, p. 323. METSCHNIKOFF, 1886, Embryol. Studien an Medusen, Wien, pp. 23, 25 (egg); 36, 37, 47 (segmentation); 75, 78 (development of hydroid).
*Oceania flavidula*, GEGENBAUR, 1856, Zeit. fur wissen. Zool., Bd. 8, p. 223, taf. 7, fig. 4. KEFERSTEIN UND EHLERS, 1861, Zoolog. Beiträge, p. 83, Leipzig. SPAGNOLINI, 1876, Atti Soc. Ital. Sci. Nat., tome 19, p. 22, tav. 3, fig. 3.
*Pandea flavidula*, AGASSIZ, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 347.
*Turritopsis armata*, HAECKEL, 1879, Syst. der Medusen, p. 65.
*Callitiara polyopthalma*, HAECKEL, 1879, Syst. der Medusen, p. 67, taf. 3, figs. 1-5.
*Tiarella parthenopia*, TRINCI, 1906, Monitore Zoologico Ital., Anno 17, p. 208, 2 figs.

Bell pyriform, flat-topped, higher than a hemisphere, with uniform, thin walls. 8 to 10 mm. high, 8 to 10 mm. wide. 60 to 100 or more slender, tapering, marginal tentacles, 1.5 times as long as the bell-diameter. These tentacles are crowded into a double row. Their

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entoderm is solid and composed of chordate cells. There is an ectodermal ocellus on the velar side of each tentacle-bulb. Velum well developed. Well-developed circular muscles in the subumbrella. There are 4 jagged-edged, slender radial-canals and a simple ring-canal. The stomach is flask-shaped, cruciform in cross-section and mounted upon a short, pyramidal, 4-sided peduncle. This peduncle is a solid, gelatinous, truncated pyramid, only about one-third to one-fifth as long as the stomach itself. It is not vacuolated as in *Turritopsis*. The 4 lips are large and recurved and extend to the middle of the bell-cavity and their edges are studded with a single row of knob-like nematocyst-warts. The 4 gonads are developed upon the interradial sides of the stomach and are longitudinal swellings with smooth outer surfaces.

The stomach and gonads are yellow or brownish-yellow. Eggs pearly-white. Lips reddish-yellow, or port-wine colored. Radial-canals, ring-canal, and tentacles milky-yellow. Ocelli reddish-brown (see fig. 91).

Found in the Mediterranean. Quite common at Naples. (See figs. 78–81.)

Vanhöffen (1902, Verhandl. Gesell. Deutsch. Naturf. Arzte, 64 Vers., Abth. Sitz., p. 121) maintains that this medusa is identical with *Callitiara polyopthalma* Haeckel of the Canary Islands, and with this I am in accord, having seen many specimens of the living medusa at Naples. Trinci, 1906, describes a medusa from Naples which resembles *O. armata* in all respects excepting that he finds no ocelli. He studied preserved specimens, however, and

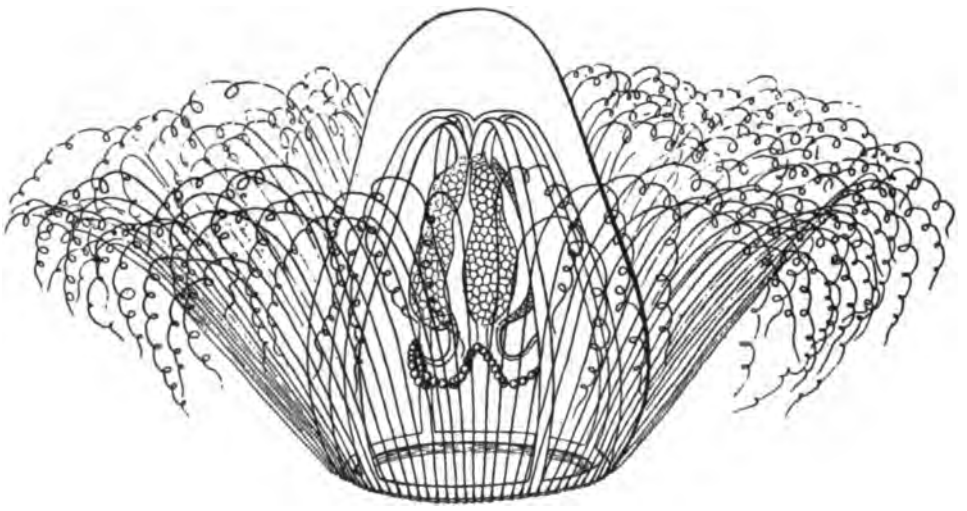

FIG. 80.—*Oceania*. "*Callitiara polyophthalma*" (*Oceania armata*), after Haeckel, 1879.

the ocelli may have faded. As Gegenbaur states, the ocelli upon the *inner* sides of the tentacle-bulbs recall the conditions seen in *Bougainvillia*, and oblige us to place the medusa among the Margelinæ. In the Tiarinæ, on the other hand, the ocelli when present are always on the *outer*, abaxial sides of the tentacle-bulbs.

Gegenbaur (1854, Zur Lehre von Generationswechsel, p. 28, taf. 2, fign. 10–16) reared the larva from the egg, and later Metschnikoff carried out a similar series of studies.

Metschnikoff, 1886, finds that the egg of this medusa is milky-white and 0.28 mm. in diameter. It is laid between 6 and 7 o'clock in the afternoon during December, in the Mediterranean. The segmentation is total, but not equal, and the resulting blastomeres form a very irregularly shaped, 1-layered mass, inclosing a large segmentation cavity. Finally, a symmetrical, egg-shaped, ciliated, planula larva is formed. The planula attaches itself and becomes a branched hydrorhiza, from which the spindle-shaped clava-like hydranths arise. These develop in about 18 days after the egg is laid. The polypite has 13 tentacles arranged alternately in 3 whorls.

In its irregularly shaped larva and in its mode of attachment this medusa resembles *Turritopsis*, to which indeed it is evidently closely related, the only distinction between *Turritopsis* and *Oceania* being that in the former the peduncle is vacuolated and in *Oceania* it is solid and gelatinous.

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### Genus STYLACTIS Allman, 1864.

*Stylactis*, Allman, 1864, Annals and Mag. Nat. Hist., ser. 3, vol. 13, p. 353; 1871, Monograph Tubularian Hydroids, p. 302. Clarke, 1882, Mem. Boston Soc. Nat. Hist., vol. 3, p. 138.- Sigerfoos, 1889, American Naturalist, vol. 33, p. 801.

These are Margelinæ in which the medusa is degenerate, and indeed in the European species of *Stylactis* no medusæ are set free, mere sporosacs being developed on the hydranths. The two American forms, however, produce free-swimming, although degenerate medusæ.

The medusa has 8 rudimentary tentacle-bulbs, 4 radial and 4 interradial; 4 simple radial-canals and a ring-canal. The manubrium is sac-like without a mouth, and without oral tentacles. The gonad encircles the sac-like manubrium, and the mature eggs or sperm are found in the ectoderm. The sexes are separate.

The hydroid, *Stylactis*, bears a resemblance to both *Hydractinia* and *Podocoryne*, but unlike the two last named the hydrorhiza is not covered with a fleshy layer of cœnosarc

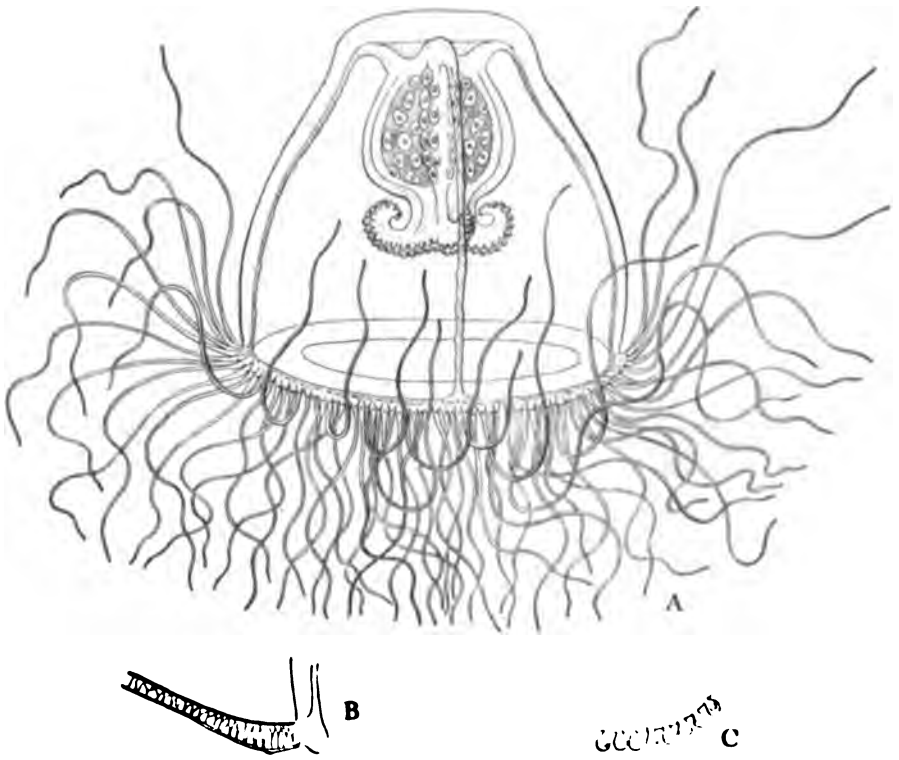


Fig. 81. -*Oceania armata*, from life, by the author. Naples Zoological Station, December 18, 1907.
A. Mature female.
B. Basal part of tentacle showing ectodermal ocellus on its velar side.
C. Part of lip, showing row of nettling-warts.

(hydrocaulus). The hydrorhiza of *Stylactis* is formed of a network of anastomosing stolons invested with a chitinous perisarc, but are without a superficial layer of naked cœnosarc. The hydranths are simple, claviform, or cylindrical, with one or two circles of filiform tentacles around the oral zone. The hydranths arise singly from the hydrorhiza and are of two sorts, reproductive and nutritive. Spines also arise from the hydrorhiza. The sporosacs, or medusa-buds, are borne upon the sides of the reproductive hydranths in an irregular circlet below the tentacles.

The type species is *Stylactis fuciola* of the Mediterranean (see Allman, 1864) which was first described by M. Sars (1857, Nyt. Mag. Naturvid., 9), under the name *Podocoryne fuciola*. Allman pointed out its peculiar characters and distinguished it from *Podocoryne*.

One of the most remarkable species is *Stylactis minoi* Alcock (1892, Annals and Mag. Nat. Hist., ser. 6, vol. 10, p. 207, 1 fig.). This is commensal upon a fish *Minous inermis*. Sporosacs, but no medusa-buds, are produced by the hydroid of this species.

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### Stylactis hooperi Sigerfoos.

*Stylactis hooperi*, SIGERFOOS, 1899, American Naturalist, vol. 33, p. 801, 5 figs.—NUTTING, 1901, Bull. U. S. Fish Commission for 1899, vol. 19, pp. 335, 374, figs. 13, 85.—HARGITT, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 41.

*Medusa.*—The medusa is degenerate and intermediate in its character between the sessile sporosacs of *Hydractinia* and the well-developed, free-swimming medusæ of *Podocoryne*. The medusæ of *Stylactis hooperi* live only a few hours after being set free from the hydroid, and die soon after setting free their genital products. The sexes are separate, the mature genital products being developed within a large part of the ectoderm of the manubrium, so that the gonad encircles it as in the Codonidæ. The evident relationship of the hydroid to *Podocoryne*, however, necessitates the medusa's being classified in connection with *Podocoryne*.

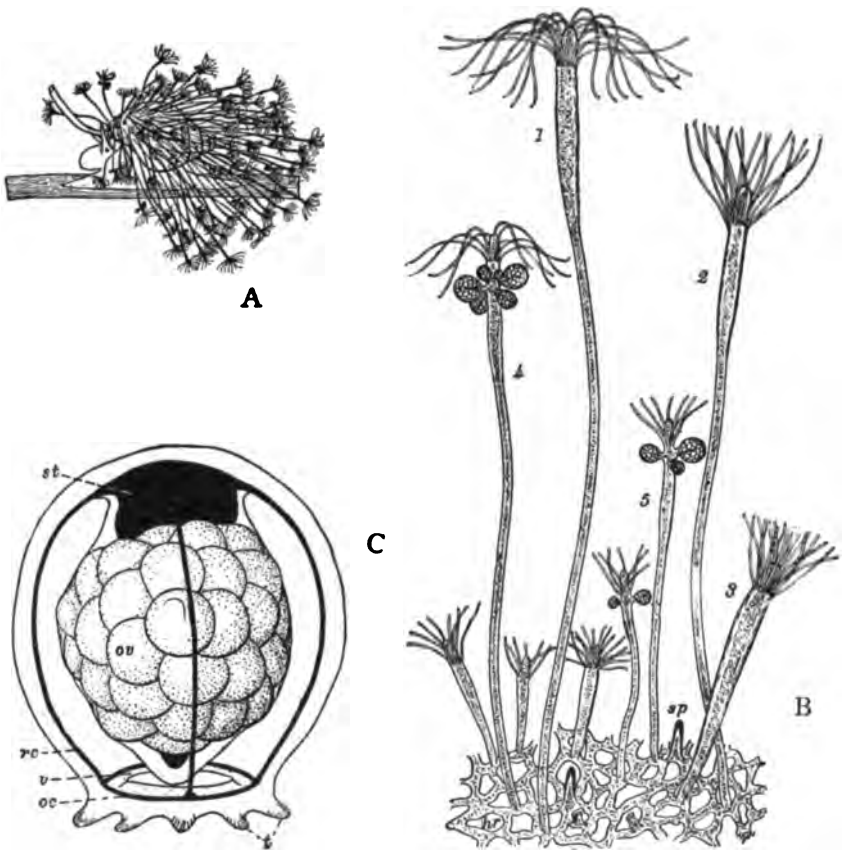


FIG. 82.—*Stylactis hooperi*, after Sigerfoos, in American Naturalist.

A. Colony shell of living *Ilyanassa obsoleta*, represented as crawling over a blade of eelgrass. Natural size.
B. Part of colony magnified 6 diameters. (1) large nutritive hydranth fully expanded; (2) same slightly contracted; (3) same fully contracted; (4) large reproductive hydranth fully expanded; (5) smaller reproductive hydranth, slightly contracted; *hr.*, tubes of hydrorhiza; *sp.*, spines.
C. Recently liberated female medusa, before extrusion of eggs. *cc.*, circular canal; *rc.*, radial-canal; *st.*, stomach; *t.*, tentacles; *v.*, velum; *ov.*, ova. × 50.

The bell is somewhat fuller than a hemisphere, with thin, uniform walls. There are 8 short, marginal tentacles, 4 radial and 4 interradial. The velum is well developed. There are 4 straight, slender radial-canals and a ring-canal. The manubrium is wide and spindle-shaped and fills the greater part of the bell-cavity. There is no mouth-opening and there are no oral tentacles. The ectoderm around the middle region of the manubrium is much distended with the genital products.

*Hydroid.*—The hydroid was found by Sigerfoos growing upon the living shells of *Ilyanassa*, especially upon snails found crawling upon eelgrass. It was found in Lloyds Harbor, Huntington Bay, in Long Island Sound, New York, during the summers of 1898-99.

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There is no hydrocaulus. The hydrorhiza is a network of tubes lying in one plane, from which arise a few small, simple spines and many sessile hydranths. The hydranths are of two kinds, nutritive and reproductive. The nutritive hydranths are about 25 mm. long and are elongate, simple, and unbranched. Their oral ends taper gradually, being widest at the circlet of tentacles. There are usually about 20 long, slender tentacles arranged in a single whorl, but specimens are found with as many as 35 and as few as 15 tentacles. The entodermal cores of these tentacles are solid and consist of a single row of cells. The tips of these tentacles are not appreciably swollen or knob-like, although they are well provided with nematocysts.

The reproductive hydranths are slightly smaller than the nutritive ones. They have only 6 to 10 tentacles and are only one-third to three-fourths as long as the nutritive hydranths, but they have functional mouths. There are usually 4 to 5 medusa-buds arranged in a circlet immediately below the circle of tentacles. The entoderm of the hydroid is white or pinkish-white. The medusæ appear to be set free soon after dark, and the breeding season extends throughout July and August.

There are no spiral protective zooids such as are found in *Hydractinia* and there is no cœnosarc layer over the hydrorhiza such as is found in *Hydractinia* and *Podocoryne*.

### Stylactis arge Clarke.

*Stylactis arge*, CLARKE, 1882, Mem. Boston Soc. Nat. Hist., vol. 3, p. 138, plate 8, figs. 18–20.

The medusiform gonophores of this species often become mature while attached to the hydroid stock. In other cases, however, the gonophores become free, although they are sexually mature at the time of liberation.

*Free medusa.*—The bell is ellipsoidal and the gelatinous substance thin. There are 8 small rudimentary tentacle-bulbs, 4 radial and 4 interradial. 4 simple, narrow radial-canals. The manubrium is globular and greatly distended by the contained genital products.

*Hydroid.*—The hydranths are very much elongated and slender. Each hydranth is provided with 10 to 30 tentacles which arise in 2 circlets close together below the hypostome. The tentacles of the lower circlet are somewhat shorter than those of the upper one, although in some individuals all of the tentacles are of equal length. There are usually 4 sporosacs or medusa-buds developed upon the sides of the body of the hydranth beneath the circlets of tentacles, 2 being first developed on opposite sides of the hydranth, and then 2 others appear at points 90° from the first pair. The entire colony is of a delicate opaque white.

It is remarkable that in this species a constriction sometimes appears around the body of a hydranth, from a point just above which two or three cylindrical, stolon-like processes are developed. The constriction then becomes complete and the distal end of the hydranth becomes free. This then settles down in a new locality and the stolon-like processes give rise to a hydrorhiza and a new colony is thus developed asexually.

This species has been found by Clarke in Chesapeake Bay.

## Genus THAMNOSTYLUS.

*Thamnostylus*, HAECKEL, 1879, Syst. der Medusen, p. 85; 1881, Report H. M. S. *Challenger*, Zool., vol. 4, p. 2.

The only known species is *Thamnostylus dinema* Haeckel, from the Antarctic Ocean.

### GENERIC CHARACTERS.

Margelinæ with branched oral tentacles and 2 marginal tentacles 180° apart. Development unknown.

### Thamnostylus dinema Haeckel.

*Thamnostylus dinema*, HAECKEL, 1879, Syst. der Medusen, p. 85; 1881, Report H. M. S. *Challenger*, Zool., vol. 4, p. 2, plate 1, 8 figs.

Bell hemispherical, 16 mm. wide, 8 mm. high, with thick gelatinous substance, but thin at margin. The margin is thickly studded with nematocysts and the exumbrella is also besprinkled with isolated nettling cells. 2 diametrically opposite, radially situated, hollow,

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marginal tentacles about 3 times as long as the bell-diameter and ringed at frequent intervals with swollen masses of nematocysts. The basal bulbs of these tentacles are swollen and conical and each one bears a dark-red abaxial ocellus. There are 2 rudimentary, ocellated tentacle-bulbs upon the margin 90° apart from the long tentacles. Velum wide. 4 straight, narrow radial-canals and a simple ring-canal.

The stomach is a wide, 4-sided pyramid, as long as the depth of the bell-cavity. It extends below into a 4-sided, elongated throat-tube, twice as long as the stomach itself. This throat-tube projects beyond the velar opening and the mouth is a simple, 4-sided opening studded with nematocysts.

4 large, radially placed, oral tentacles arise from the distal end of the stomach and branch dichotomously 6 to 8 times, their ends terminating in nematocyst-knobs. The gonads are swollen, leaf-like, lobular, folded ridges in the 8 adradii of the stomach. They are blunt above, but more pointed below, and each gonad exhibits about 5 double transverse folds. The ova are prominent. The gonads, oral tentacles, nematocysts of bell-margin and of the tentacles and tentacle-bulbs are blood-red.

Antarctic Ocean, south of the Kerguelen Islands, at a depth of 120 fathoms. Beautifully figured by Haeckel, 1881.

### Genus THAMNITIS Haeckel, 1879.

*Thamnitis*, HAECKEL, 1879, Syst. der Medusen, p. 84.—VANHÖFFEN, 1891, Zool. Anzeiger, Bd. 14, p. 444.—BROWNE, 1905, Proc. Royal Soc. Edinburgh, vol. 25, p. 758.

The first described species of this genus is *Thamnitis nigritella*, first made known by Forbes, 1848, under the name *Bougainvillea nigritella*. The first species mentioned by Haeckel is a newly-described form, *Thamnitis tetrella*. *T. nigritella* comes from the Shetland Islands, while *T. tetrella* was obtained off the coast of Brazil.

#### GENERIC CHARACTERS.

Margelinæ with branched oral tentacles and 4 simple, radially placed, marginal tentacles.

It is possible that *Thamnitis* may be simply an immature or damaged *Bougainvillia* which has lost all but one marginal tentacle of each radial cluster, but we are not yet justified in concluding that this is the case. Forbes, 1848, describes and figures the tentacle-bulbs of *Thamnitis nigritella* as being bean-shaped, containing a single large ocellus (?) or mass of very dark pigment, and having a single short tentacle arising from one side of the bulb, not from the middle. Haeckel, 1879, p. 84, describes *T. tetrella* as having small, pear-shaped tentacle-bulbs with a single tentacle arising from the middle of each bulb. He does not mention ocelli, but his description is brief and unaccompanied by a figure. Further study is required before we can be certain that *Thamnitis* actually exists in nature. Vanhöffen, 1891, accepts it with some hesitation, and I share his view in this respect.

Browne, 1905 (Proc. Roy. Soc. Edinburgh, vol. 25, p. 758), is the only recent author who has seen a specimen of *Thamnitis*. He found two small, immature medusæ in the Firth of Clyde, Scotland, in September to October. They were 1 to 1.5 mm. wide and had 4 simple, marginal tentacles. No ocelli. 4 oral tentacles 2 to 3 times dichotomously branched. No gonads. Stomach yellow to orange, tentacle-bulbs orange.

"*Thamnitis nigritella*" Forbes, 1848 (British Naked-eyed Medusæ, p. 63, plate 12, fig. 2) is probably an immature *Bougainvillia* which has lost all but one tentacle in each marginal cluster.

#### Thamnitis tetrella Haeckel.

*Thamnitis tetrella*, HAECKEL, 1879, Syst. der Medusen, p. 84.

Bell egg-shaped, being 6 mm. in height and 4 mm. in diameter. There are 4 radially situated, marginal tentacles which are longer than the bell-height. Each tentacle arises from the middle of a large basal bulb. An ocellus is situated at the base of each tentacle. There are 4 radial-canals. The manubrium is cubical with a wide quadratic base. There are 4 radially situated, oral tentacles, each of which branches dichotomously three times. The gonads are found in 4 interradial (?) swellings upon the wall of the stomach. Color (?) This species is found upon the coast of Brazil.

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## Genus LYMNOREA Péron et Lesueur.

(?) *Favonia*, Péron et Lesueur, 1809, Hist. Gén. des Meduses, p. 16.
*Lymnorea*, Péron et Lesueur, 1809, Ann. Mus. Hist. Nat. Paris, tome 14, p. 329. de Blainville, 1834, Manuel d'Actinol., p. 290. Mayer, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 6; 1904, Mem. Nat. Sci. Brooklyn Inst. Museum, vol. 1, p. 10.—Agassiz and Mayer, 1902, Mem. Mus. Comp. Zool. at Harvard College, vol. 26, p. 144.
*Limnorea + Thamnostoma*, Haeckel, 1879, Syst. der Medusen, pp. 85, 86.
*Limnorea + Thamnostoma*, Vanhoffen, 1891, Zool. Anzeiger, Bd. 14, p. 445.
*Macradia*, Brooks and Rittenhouse, 1907, Proc. Boston Soc. Nat. Hist., vol. 33, p. 437.

The oldest species of this genus is *Lymnorea triedra*, described by Péron and Lesueur, and first figured by de Blainville, 1834. It occurs on the southern coast of Australia. The figures and description leave much to be desired, but the branching oral tentacles are clearly represented. The marginal tentacles are small and numerous.

### GENERIC CHARACTERS.

Margelinæ with branched oral tentacles and with 8 or more marginal tentacles which arise separately, not in clusters, from the bell-margin. The hydroid is unknown.

Haeckel, 1879, would call medusæ with 8 marginal tentacles *Thamnostoma*, and those with 16 or more *Limnorea*. He introduced the spelling *Limnorea*, but Péron and Lesueur spell it *Lymnorea*. Owing to the very incomplete description of Péron and Lesueur it is impossible to determine whether *Favonia* is or is not equivalent to *Lymnorea*. Judging from de Blainville's, 1834, copy of Péron and Lesueur's unpublished figure, it appears to be closely allied to *Lymnorea*, but its relationships must remain uncertain. *Favonia* takes precedence over *Lymnorea*, should it be equivalent, for it precedes *Lymnorea* in Péron and Lesueur's description.

### Lymnorea dibalia.

*Lizzia dibalia*, Busch, 1851, Beobach. wirbellos. Seeth., p. 23, taf. 1, figs. 7–9.
*Thamnostoma dibalis*, Haeckel, 1879, Syst. der Medusen, p. 86.—Graeffe, 1884, Arbeit. Zool. Inst. Wien., Bd. 5, p. 348.

Bell oval, 7 mm. high, 6 mm. wide. 8 marginal tentacles, those at the bases of the 4 radial-canals being longer than the 4 interradial tentacles. The ocelli are borne upon projections, one of which arises from each tentacle-bulb. The stomach is cubical and lacks a peduncle, and the throat-tube is as long as the stomach. There are 4 oral tentacles which branch dichotomously twice. 4 swollen gonads on the interradial sides of the stomach.

Found at Trieste, Adriatic Sea, Mediterranean. Graeffe states that the mature medusæ are found in October, and the young first appear in September.

### Lymnorea macrostoma.

*Thamnostoma macrostoma*, Haeckel, 1879, Syst. der Medusen, p. 86.

Bell cubical, 8 mm. high, 8 mm. wide. 8 similar marginal tentacles, each longer than the bell-diameter. A simple, abaxial ocellus at the base of each tentacle. Stomach globular without a peduncle. The throat-tube is 3 times as long as the stomach and extends beyond the velar opening. There are 4 short, oral tentacles, each of which branches dichotomously 6 to 8 times, thus giving rise to 80 to 100 terminal branches in each quadrant. 4 gonads on sides of stomach. Color (?) Indian Ocean, Singapore.

### Lymnorea ocellata Agassiz and Mayer.

*Lymnorea ocellata*, Agassiz, A., and Mayer, 1902, Mem. Museum Comp. Zool. at Harvard Coll., vol. 26, p. 144, plate 2, figs. 9–12.
(?) *Lymnorea triedra*, Péron et Lesueur, 1809, Annal. du Mus. Hist. Nat. Paris, tome 14, p. 329; de Blainville, 1834, Man. Actinologie, p. 290, plate 40, fig. 2; Haeckel, 1879, Syst. der Medusen, p. 87.
(?) *Limnorea proboscidea*, Haeckel, 1879, Syst. der Medusen, p. 87.
(?) *Limnorea proboscidea*, Bedot, 1901, Revue Suisse de Zool., tome 9, p. 484; *Ibid.*, 1905, tome 13, p. 137.

The top of the bell is flat and the sides flare outward in a bell-shaped manner. The bell is about 4 mm. in diameter and is about as high as it is broad. The walls are thin and quite flexible. There are about 50 short, stiff tentacles which are each about half the length of the bell-height. These tentacles are usually carried curled upward and their entodermal cores are solid and composed of vacuolated chordate cells. The basal bulbs of the tentacles are large

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and each contains a mass of red entodermal pigment. In addition to this there is a prominent ectodermal ocellus upon the velar side of each tentacle at a short distance outward from the basal bulb. The velum is narrow. There are 4 straight, narrow radial-canals and a slender circular vessel. The peduncle of the manubrium is wide and quadratic in cross-section and its lower portion near the stomach consists of highly vacuolated, entodermal cells. The stomach is pear-shaped and the mouth is a simple, round opening. The entire manubrium extends about half the distance from the inner apex of the bell-cavity to the level of the velar opening. There are 4 well-developed, radially placed, oral tentacles, each one of which is about half as long as the height of the manubrium. Each oral tentacle branches dichotomously 4 times, thus giving rise to 16 distal knobs. Each knob is thickly covered with a bristling cluster of fusiform nematocyst-cells. In addition to these there are several patches of nematocystic bristles upon the sides of the main shaft of each oral tentacle. The gonads are developed in 4 interradial regions on the walls of the stomach. The entoderm of the tentacle-bulbs and of the stomach is brick-red. The ectodermal ocelli are black. A number of these medusæ were obtained on the surface in the lagoon of Makemo Island, Paumotus, South Pacific, on October 23, 1899.

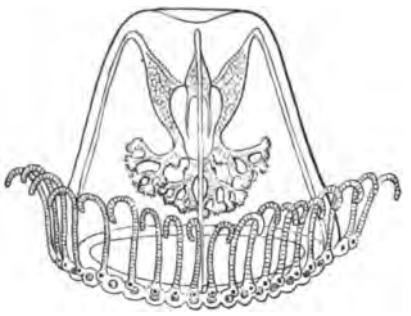

FIG. 83.—*Lymnorea ocellata*, after Agassiz and Mayer, in Mem. Museum Comp. Zool. at Harvard College.

This species may be identical with *Lymnorea triedra* Péron et Lesueur = *L. proboscidea* Haeckel, but the published drawing of this medusa is evidently inaccurate and the description so brief and vague that it will probably never be possible to redetermine the species. *L. triedra* is described from Bass Strait, between Australia and Tasmania.

### Lymnorea borealis Mayer.

Plate 15, figs. 1 to 3.

*Lymnorea borealis*, MAYER, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 6, figs. 16–18, plate 5.
(?) *Limnorea nowegica*, BROCH, 1905, Bergens Museums Aarbog, No. 11, p. 5.
(?) *Cytæanda areolata*, BROWNE, 1897, Proc. Zool. Soc. London, p. 817, plate 48, figs. 1, 2. (*Podocoryne?*)

Bell 3 mm. high. It is higher than a hemisphere and is acorn-shaped, with a low, blunt apical projection. The bell-walls are thin. There are 32 marginal tentacles, each about half as long as the bell-height. They are quite stiff and are carried curled upward, above the margin. Their basal bulbs are large and densely pigmented. The velum is well developed. There are 4 straight, narrow radial-canals and a slender, simple, circular vessel. The manubrium is slender and pyriform and mounted upon a very short, solid peduncle. It is cruciform in cross-section. The mouth is flanked on its 4 radial corners by 4 short dichotomously branching oral tentacles (plate 15, fig. 2). Each oral tentacle branches dichotomously twice, thus giving 4 tentacle tips in each quadrant. These tentacle tips are knob-like and armed with long spindle-shaped nematocysts (plate 15, fig. 3) very much as are the oral tentacles of *Lymnorea ocellata*. The 4 gonads are found in four longitudinal, interradial, swollen regions in the ectoderm of the stomach-wall. The immature eggs are transparent and give a reticulate appearance to the surface of each gonad. The entoderm of the manubrium and tentacle-bulbs is bright-red. There are no ocelli.

Three specimens were taken on the surface at Eastport, Maine, on September 19, 1898.

Broch, 1905, gives a brief description of a *Lymnorea* from the coast of Norway which may be identical with this species. He states that there is a pair of very short, oral tentacles at each of the 4 corners of the mouth and that each of these forks dichotomously twice, thus giving 8 terminal knobs at each radial corner of the mouth. There are 16 to 22 tentacles. In other respects his description accords with that of *L. borealis*, allowance being made for contraction due to preservation in Broch's specimen. He gives no figures and does not mention the color.

### Lymnorea alexandri Mayer.

Plate 15, figs. 4 to 9.

*Lymnorea alexandri*, MAYER, 1906, Mem. Nat. Sci. Museum Brooklyn Institute, vol. 1, p. 10, plate 1, figs. 1–5*a*.
*Mecradia*, *sp.*, BROOKS and RITTENHOUSE, 1907, Proc. Boston Soc. Nat. Hist., vol. 33, p. 435, plate 31, fig. 8.

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Bell 4 mm. high, 3 mm. broad, with vertical sides, flat top, and thin walls. 32 slender tentacles with tightly coiled ends and large basal bulbs. A black, ectodermal ocellus lies upon the velar side of each tentacle-bulb (plate 15, fig. 9). The velum is well developed. The 4 radial-canals are straight and slender, but slightly swollen in the mid-region of their lengths, where their inner sides are lined with gland-cells (plate 15, fig. 6). The manubrium is flask-shaped, and about half as long as the depth of the bell-cavity. The distal part of the manubrium adjacent to the points of entrance of the 4 radial-canals is composed of highly vacuolated cells. The mid-region of the manubrium is cruciform in cross-section and the mature genital products are found in the ectoderm of the 4 interradial sides of the stomach. The mouth is at the extremity of a short neck and is surrounded by 4 oral tentacles, each of which branches dichotomously 3 times and terminates in 8 nematocyst-bearing knobs, making in all 32 of these knobs surrounding the mouth (plate 15, fig. 5). The entoderm of the manubrium and tentacle-bulbs is dull, flesh-colored pink. In the youngest medusa seen the bell was 0.6 mm. in diameter and had only 4 oral tentacle-knobs, 4 marginal tentacles, and 4 rudimentary tentacle-bulbs. This is one of the most abundant medusæ upon the surface in summer, among the Bahama Islands. A single specimen was found at Tortugas, Florida, in July, 1905. Named in honor of Dr. Alexander Agassiz.

## Genus BOUGAINVILLIA Lesson, 1836.

*Cyanea bougainvillii*, Lesson, 1830, Voyage de la *Coquille*, Zool., tom. 2, part. 2, 2e div., p. 118, plate 14, Zoophytes, figs. 3, D, D′, D″, D‴.
*Bougainvillia*, Lesson, 1836, Ann. des Sci. Nat., Zool., sér. 2, tom. 5, p. 262.
*Hippocrene*, Brandt, (Mertens), 1835, Mém. Acad. Impériale des Sci. St. Pétersbourg, Sci. Nat., sér. 6, tome 2, p. 229. Preoccupied by Oken, 1817, for Mollusca.—Agassiz, L., 1849, Mem. Amer. Acad., New Series, vol. 4, p. 250.
*Bougainvillea*, Forbes, 1848, British Naked-eyed Medusæ, p. 61.
*Bougainvillia*, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 344.—Agassiz, A., 1865, North Amer. Acal., p. 152.
*Lizzia* (young medusa), Haeckel, 1879, Syst. der Medusen, p. 80.
*Hippocrene*, Haeckel, 1879, Syst. der Medusen, p. 90.
*Bougainvillia*, Hartlaub, 1897, Wissen. Meeresuntersuch. auf Helgoland, Heft 1, Abt. 2, p. 455.
*Bougainvillea*, Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 10.
*Bougainvillia*, Goette, 1904, Zool. Anzeiger, Jahrg. 27, p. 473.—Hallez, 1905, Compt. Rend. Acad. Sci. Paris, tom. 140, p. 457.
*Margelis*, Steenstrup, 1850, Videnskab. Meddel. fra den Nat. For., Kjöbenhavn, Nr. 1-3, p. 35.
*Margelis*, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 344.—Agassiz, A., 1865, North Amer. Acal., p. 155. Haeckel, 1879, Syst. der Medusen, p. 87.—Hartlaub, 1897, Wissenschaft. Meeresuntersuch. Biol. Anstalt auf Helgoland, Bd. 2, Heft 1, Abt. 2, pp. 472, 473.
*Bougainvillia*, Hargitt, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 37.
*Bougainvillea*, Gerd, 1892, Zool. Anzeiger, Bd. 15, p. 312, 5 figs. (cell-division, development of morula).

Fig. 84. *Bougainvillia "muscus,"* after Allman, in Ray Society, 1871-1872.

### GENERIC CHARACTERS.

Margelinæ with 4 radially placed clusters of marginal tentacles, the tentacles of each cluster being all of one kind and similar in structure each to each. Hydroid: *Bougainvillia.*

There are 4 radially placed, dichotomously branching, oral tentacles, a quadratic manubrium, 4 radial-canals, and gonads on the interradial or adradial sides of the stomach as in other Bougainvillidi.

The type species of the genus is *Bougainvillia macloviana* Lesson, 1836, from the Falkland Islands. This medusa was first described and figured by Lesson, in 1830, under the name *Cyanea bougainvillii*. The generic name "*Cyanea*" was, however, previously used by Péron and Lesueur, 1809, for Discomedusæ. Also the name *Hippocrene* of Brandt (Mertens), 1835, was preoccupied in 1817 by Oken for Mollusca and can not be applied to Medusæ. It therefore becomes necessary to adopt the generic name *Bougainvillia.*

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The name "*Margelis*" was first proposed by Steenstrup, 1850, and applied to designate *Margelis principis* of the North Sea, and this name was adopted by Agassiz and Haeckel. They would designate "*Margelis*" as being similar to *Bougainvillia*, but with a manubrium having a narrow base devoid of a peduncle and with the 4 radial-canals opening close together into the 4 corners of the narrow stomach. *Bougainvillia*, on the other hand, they would restrict to designate medusæ with a wide quadratic stomach and often with a peduncle, the 4 radial-canals arising far apart from the 4 corners of the wide cruciform stomach. While these distinctions serve admirably to distinguish "*Margelis*" *principis* or "*M.*" *carolinensis* from *Bougainvillia superciliaris*, they fail completely to classify medusæ in which the manubrium is of moderate width, neither wide nor narrow. It is my object to retain only positive,

FIG. 85.—*Bougainvillia "fruticosa,"* after Allman, in Ray Society, 1871–72.

not relative, characters as of generic value. It is futile and confusing to attempt to separate genera upon such intergrading differences as "wide or narrow stomach," "long or short manubrium," etc., for we generally find that species will be discovered allied evidently to both these so-called "genera," but strictly intermediate in essential characters. *Bougainvillia* takes precedence over *Margelis* and should therefore supplant it.

Forbes, 1848, introduced the spelling *Bougainvillea*, but Lesson's original proposition is *Bougainvillia*.

Haeckel, 1879, p. 90, confuses the hydroid of *Bougainvillia* with *Eudendrium*, but in *Eudendrium* no free medusæ are produced and there are other distinctions separating it from *Bougainvillia*.

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*Nemopsis* is separated from *Bougainvillia* by the tentacles, composing its 4 radially situated, marginal clusters, being of two distinct kinds (clubbed and simple-ended). The marginal tentacles of *Bougainvillia* are all of one sort and do not terminate in knobs. Vanhöffen, 1891, shows that we can not separate *Nemopsis* from *Bougainvillia* upon the mere length of the radial pouches of its stomach, for some medusæ of *Bougainvillia* display pouches of considerable length.

*Tabular Synopsis of the Medusæ of Bougainvillia.*

| | B. macloviana Lesson. | B. principis = Margelis principis Steenstrup. | B. fulva Agassiz and Mayer. | B. britannica Forbes. | B. superciliaris L. Agassiz. | B. dinema Greene = B. superciliaris (?)* | B. multicilia = Lizusa multicilia Haeckel.† |
|---|---|---|---|---|---|---|---|
| Shape and size of bell in mm. | Cylindrical, with rounded top. 15 high, 13 wide. | Nearly spherical. 7 wide, 6 high. | Cylindrical, with flatly rounded top. 14 high, 11 wide. | High, dome-like. Thick-walled. | Dome-like, with bulging sides. 10 high, 10 wide. | Dome-like, with bulging sides. 12 high, 8 wide. | 0.75 spherical. 6 high, 5 wide. Thin uniform bell-walls. |
| Number of tentacles upon each of the 4 marginal bulbs. | 35 to 65 in double row. | 25 to 30 in single row. | 15 to 20 in single row. | 16 to 20. Very short, in single row. | 10 to 15. 32 in the variety B. aurea. | 10 to 12 (?) Only 2 perfect tentacles seen. | 10 to 12 |
| Shape of marginal bulbs. | V-shaped. | Long, linear; wider than spaces between them. | Epaulet-shaped. | Epaulet-shaped. | Elongate, oval basal bulbs, of small size. | Kidney-shaped. | Kidney-shaped. |
| Shape and size of manubrium. | Small, cubical. On broad, conical peduncle. | Short, wide. 4-sided. Only one-third as long as depth of bell-cavity. | Wide. Half as long as depth of bell-cavity. No peduncle. | 4-sided, wide, urn-shaped. No peduncle. Only about half as long as depth of bell-cavity. | Wide, 4-sided, and flask-shaped. Mounted on peduncle 1.5 to two-thirds as long as depth of bell-cavity. | Small, balloon-shaped, 4-sided, hardly one-fourth as long as bell-height. | Globular to flask-shaped with constricted base. No peduncle. |
| Number of dichotomous branchings of each of the 4 oral tentacles. | 6 to 7 times. | 4 to 5 times. | 8 times. | 6 to 7 times. | About 5 times. 7 times in the variety B. aurea. | 4 to 5 times. | Simple, unbranched. |
| Character of gonads. | 4 wide, folded, interradial swellings. | 4 spherical, interradial. | 8 adradial. | 8 adradial. No planulæ remain attached to stomach. | 4 interradial. Planulæ develop in capsules upon sides of stomach. | 4 interradial. | 8 adradial. |
| Color. | Stomach and tentacle-bulbs yellow. Gonads and ocelli brownish-black. | ? | Stomach and tentacle-bulbs orange, yellow, brownish-yellow. Ocelli black. | Stomach and tentacle-bulbs golden-yellow. Ocelli black. | Stomach and tentacle-bulbs rosin-yellow to reddish-brown. Ocelli black. | Stomach and tentacle-bulbs yellow. Ocelli black. | Stomach light-yellow. Tentacle-bulbs orange-yellow. Ocelli dark-red. |
| Where found. | Falkland Islands, South Atlantic. | North Sea, coast of Scotland. | Tropical Pacific, Fiji to Malay Archipelago. | North Atlantic coasts of Europe and America. | Arctic Ocean, northern coasts of Europe and America. | East coast of Ireland. | Straits of Gibraltar. |
| Hydroid. | Unknown. | Unknown. | Unknown. | Hydroid has been commonly called B. "ramosa." | B. superciliaris. | | |

*This medusa appears to be *B. superciliaris* which has lost some tentacles. *B. aurea*, Lanko, 1904, is probably a variety of *B. superciliaris* from Arctic Ocean.

†An immature medusa?

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The definitions of *Bougainvillia* and *Nemopsis* here proposed are identical with those of Hargitt, 1904, p. 37.

Species of *Bougainvillia* are widely distributed in all seas, but are especially abundant in the cold waters of the northern hemisphere, a remarkably large number being found in the North Sea near Helgoland, by Hartlaub, 1897. Many of the species are very closely related and their distinctions may be due in part to environmental influences. Hallez found that

*Tabular Synopsis of the Medusæ of Bougainvillia.*—Continued.

| | B. platygaster Haeckel. | B. xantha Hartlaub.* | B. carolinensis = Hippocrene carolinensis McCrady. | B. niobe Mayer. | B. pyramidata = Hippocrene pyramidata Forbes. | B. nordgaardii = Margelis nordgaardii Browne. | B. flavida Hartlaub. |
|---|---|---|---|---|---|---|---|
| Shape and size of bell in mm. | Cubical. 12 high, 12 wide. | Dome-like, walls very thick. 6 high, 5 wide. | Dome-like. Very thick walls. 4 high, 4 wide. | Cylindrical, with flatly-rounded apex. 6.75 high, 4.8 wide. Bell-walls thick. | Semi-globular. 6 high, 6 wide. Walls thick. | Oval. 4 high, 4 wide. Walls only fairly thick. | Oval. 3 wide, 2 high. Walls thick. |
| Number of tentacles upon each of the 4 marginal bulbs. | 10 to 12 | 9 to 10 | 7 to 9 very long and slender. | 8 | 6 to 8 | 5 to 7. No ocelli. | Not more than 6. |
| Shape of marginal bulbs. | Triangular, wider than spaces between them. | Small, oval to globular. | Small, thick, bulbous. | Small, oval. | Small, globular. | Small, globular. | Swollen, fairly large, bulbous. |
| Shape and size of manubrium. | Flat, 4-sided. No peduncle. | Spindle-shaped. No peduncle. | Narrow, widest near mouth. Half as long as depth of bell-cavity. | Flask-shaped. Cruciform in cross-section. Half as long as depth of bell-cavity. | Flat, cruciform, mounted upon peduncle. | Half as long as depth of bell-cavity. | Small, conical, about half as long as depth of bell-cavity. No peduncle. |
| Number of dichotomous branchings of each of the 4 oral tentacles. | 3 or 4 times. | About 2 or 3 times. | 2 times. | 4 times. | 2 times. | 4 or 5 times. | 3 times. |
| Character of gonads. | 4 interradial. | 4 interradial. | 4 interradial. | Medusa-buds arise from 8 adradial sides of stomach. | Gonads on base and lobes of stomach. | 4 interradial. | 4 interradial. |
| Color. | Stomach and tentacle-bulbs reddish-yellow. Ocelli? | Stomach and tentacle-bulbs golden-yellow, reddish-yellow. Ocelli small, brownish-violet. | Variable, usually stomach and tentacle-bulbs green or green and red. Ocelli black. | Stomach and tentacle-bulbs rosin-yellow. | Stomach and tentacle-bulbs orange to yellow to reddish-brown. | Gonads and tentacle-bulbs yellowish-brown (in formalin). No ocelli. | Stomach and tentacle-bulbs orange-yellow. Ocelli black. |
| Where found. | Eastern parts of tropical Atlantic. Cape Verde, Canary Islands. | Helgoland, German Ocean. | Atlantic coast of United States, Woods Hole to Tortugas. | Bahama Islands, tropical Atlantic. | West coast of Scotland, south of Ireland. | Near Bergen, Norway. | Helgoland, German Ocean, August to September. |
| Hydroid. | Unknown. | Unknown. | Hydroid: B. carolinensis. | Unknown. | Unknown. | Unknown. | Hydroid: B. flavida Hartlaub. |

*Medusa allied to *B. flavida*.

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*B. fruticosa* Allman is a form of *B. ramosa* Van Beneden, which grows in agitated water. The observations of Graeffe, 1884 (Arbeit. Zool. Inst. Wien., Bd. 5, p. 349), are interesting in the same connection, for he found that five distinct forms of *Bougainvillia* medusæ arise from a hydroid apparently identical with *Bougainvillia muscus* Allman. It is therefore probable that many of our so-called "species" of *Bougainvillia* are merely environmental races. The hydroids of most of them remain unknown, or are not associated with any known medusa, and many of the species are imperfectly described. The following descriptions must be considered as only tentative attempts to unravel the confusion which prevails at present and which can not be dissipated until the hydroids of all or most of the species are discovered.

Haeckel's 1879, genus "*Lizusa*" appears to apply only to immature specimens of *Bougainvillia* in which the oral tentacles have not yet become branched.

*Tabular Synopsis of the Medusæ of Bougainvillia.**—Continued.

| | B. autumnalis Hartlaub = B. gibbsi Mayer. | B. prolifera = Lizusa prolifera von Lendenfeld. | B. maniculata Haeckel. | B. rugosa Clarke. | B. trinema = Margelis trinema von Lendenfeld. | B. frondosa Mayer. |
|---|---|---|---|---|---|---|
| Shape and size of bell in mm. | Dome-like. 2.5 high, 2 wide. Thick walls. | Dome-like. 3 high, 2.5 wide. | Nearly spherical. 1.5 high, 1.5 wide. Thin walls. | Pyriform. 1.5 high. | Oval. 3 wide. | Dome-like with vertical sides. 2 high, 1.25 wide. Walls thick. |
| Number of tentacles upon each of the 4 marginal bulbs. | 3 to 6 | 5 | 4 short, finger-shaped. | 3 | 3 | 2. No ocelli. |
| Shape of marginal bulbs. | Rounded, bulbous, fairly large. | Large, "scrotal-shaped." | Small, globular. | Small, globular. | Small. | Small, without ocelli. |
| Shape and size of manubrium. | Short urn-shaped, wide, 4-sided. Not half as long as depth of bell-cavity. No peduncle. | Small, nearly cubical. | Flask-shaped. Narrow base, spherical stomach. Long, conical throat. | Short, thick, flask-shaped. | Small. | Cruciform, short, thick, flask-shaped. Half as long as depth of bell-cavity. |
| Number of dichotomous branchings of each of the 4 oral tentacles. | 2 or 3 times. | Simple unbranched. | Twice. Only tips branched. | Unbranched, simple. | Each ends in 3 branches. | 2 or 3 times. |
| Character of gonads. | 4 interradial. | Medusa-buds on sides of stomach. | 4 interradial. | Not developed (immature). | ? Not developed. | 8 adradial. Planulæ develop upon sides of stomach. |
| Color. | Stomach green-brown. Tentacle-bulbs yellowish-greenish-yellow. Ocelli black. | Stomach and tentacle-bulbs brown. | Stomach and tentacle-bulbs violet-gray. | Stomach and tentacle-bulbs yellow, brown. | Stomach and tentacle-bulbs dark-yellow. | Stomach and tentacle-bulbs pinkish-white. Tentacle-tips turquoise. |
| Where found. | Newport, United States. Helgoland, German Ocean. August to November, and off British coasts. | Port Jackson, New South Wales, March to April. | Mediterranean. | Virginia to South Carolina, Atlantic coast of United States. | Port Jackson, New South Wales, Australia. | Tortugas. |
| Hydroid. | Hydroid unknown. | An immature form? Unknown. | Unknown. | Hydroid: B. rugosa Clarke. | Unknown. | Unknown. |

* For *B. obscura* Bonnevie and *B. glorietta* Torrey, see text.

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There is considerable variability in coloration among individuals of the same species in many forms of *Bougainvillia*. The preceding tables present a synopsis of the so-called "species," although it is probable that some of the small medusæ listed near the end are only the young of those described higher up on the table.

Gerd, 1892, finds that the segmentation in the egg of *Bougainvillia* is at first total and equal and a central segmentation cavity is formed. Then the cells divide tangentially and the nuclei take up a peripheral position. Later there is multipolar ingression into the segmentation cavity and thus a solid morula is formed, having all cells similar each to each. The peripheral layer of cells forms the ectoderm of the planula larva. Before the formation of the ectoderm the cell boundaries become indistinct as in *Turritopsis*, but later they reestablish themselves.

### Bougainvillia macloviana Lesson.

*Cyanea bougainvillii*, LESSON, 1830, Voyage de la *Coquille*, Zool., tome 2, part 2, 2d div., Zoophytes, p. 118, plate 14, figs. 3, D-D'''.
*Bougainvillea macloviana*, LESSON, 1843, Hist. Zooph. Acal., p. 290.—AGASSIZ, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 344.
*Hippocrene macloviana*, HAECKEL, 1879, Syst. der Medusen, p. 90, taf. 5, fign. 1, 2.—BROWNE, 1902, Annals and Mag. Nat. Hist., ser. 7, vol. 9, p. 278.—BEDOT, 1905, Revue Suisse de Zool., tome 13, p. 135 (literature 1830–50).

*Adult medusa.*—Umbrella a little higher than broad, about 15 mm. high, with a quadrangular margin, and with longitudinal furrows on the exumbrella. There are 4 V-shaped, radially situated tentacle-bulbs, each giving rise to about 35 to 65 tentacles arranged in a double row. There is a single ocellus at the base of every tentacle. The stomach is small, cubical, and situated upon a broad, cone-shaped peduncle. 4 narrow, perradial lobes extend outward from the stomach along the whole length of the peduncle. The mouth is small, with 4 short, perradial lips placed at a point about two-thirds down the depth of the umbrella-cavity. There are 4 closely and thickly branched tentacles, each with 80 to 100 terminal branches ending in knob-like clusters of nematocysts. The gonads are developed upon the interradial sides of the stomach and extend over the sides of the perradial lobes of the stomach, hanging down in a folded band from the peduncle. The stomach and tentacle-bulbs are yellow, while the gonads and ocelli are brownish to black. This species is abundant at the Falkland Islands. Mature specimens were recently obtained by Vallentin between November and February at Stanley Harbor and described by Browne. Haeckel's specimens appear to have been immature.

### Bougainvillia principis.

*Margelis principis*, STEENSTRUP, 1850, Vidensk. Meddel. Nat. For. Kjöbenhavn, p. 35.
*Bougainvillea fruticosa+B. Allmani*, ROMANES, 1876–77, Journal Linnean Soc. London, Zool., vols. 12, 13, pp. 526, 190.
*Margelis principis*, HAECKEL, 1879, Syst. der Medusen, p. 88, taf. 6, fign. 14–16.—BROWNE, 1895, Proc. and Trans. Liverpool Biol. Soc., vol. 9, p. 266.

Bell nearly spherical, 6 to 7 mm. wide, 5.6 mm. high. Bell-walls only moderately thick and quite uniform. 4 marginal clusters of tentacles. Each cluster arises from an epaulet-shaped base, and contains 25 to 30 short tentacles, shorter than the bell-radius. There is an ectodermal ocellus on the velar side of each tentacle near its base. The basal epaulets of the tentacles are somewhat wider than the interradial parts of the margin between them.

The stomach is short, swollen, and without a peduncle. It is not half as long as the depth of the bell-cavity, and its interradial sides are occupied by 4 swollen gonads. The 4 oral tentacles each branch dichotomously 4 to 5 times, thus giving 20 to 30 knob-shaped, terminal branches in each quadrant. Color (?)

Found off the eastern coast of Scotland and in the North Sea, at Far-Oer Island.

The hydroid is unknown.

This medusa is distinguished by its short stomach and the remarkable length of its marginal tentacle-epaulets, which are linear, not triangular, in outline.

### Bougainvillia fulva Agassiz and Mayer.

*Bougainvillea fulva*, AGASSIZ, A., and MAYER, 1899, Bull. Mus. Comp. Zool. at Harvard College, vol. 32, p. 162, plate 2, fig. 6; *Ibid.*, 1902, Mem. Mus. Comp. Zool. at Harvard Coll., vol. 26, p. 145, plate 2, fig. 8.—MAAS, 1905, Craspedoten Medusen der *Siboga* Exped., Monog. 10, p. 10, taf. 1, fig. 8; taf. 2, fign. 9, 10; 1906, Revue Suisse de Zool., tome 14, p. 87, plate 2, figs. 4, 5.—BIGELOW, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 195, plates 6 and 44.

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PLATE 17.

Fig. 1. *Bougainvillia superciliaris*. Showing planulæ developing upon the interradial sides of the manubrium. Woods Hole, Massachusetts.

Fig. 2. *Bougainvillia rugosa*, young medusa. Charleston Harbor, South Carolina, December 17, 1904.

Fig. 3. *Bougainvillia autumnalis*, young medusa. Agassiz Laboratory, Newport, Rhode Island, July, 1902.

Fig. 4. *Bougainvillia autumnalis*, mature female. Agassiz Laboratory, Newport, Rhode Island, August, 1892.

Fig. 5. *Nemopsis bachei*. One of the median marginal tentacles of the medusa shown in figure 6.

Fig. 6. *Nemopsis bachei*, mature male. Hampton Roads, Virginia, November 1, 1904.

Fig. 7. *Bougainvillia carolinensis*, mature male. Charleston Harbor, South Carolina, September 10, 1897.

Fig. 8. *Bougainvillia britannica*, mature female. Eastport, Maine, September 19, 1898.

Drawn from life, by the author.

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PLATE 17.

Fig. 1. *Bougainvillia superciliaris*. Showing planulæ developing upon the interradial sides of the manubrium. Woods Hole, Massachusetts.

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Fig. 4. *Bougainvillia autumnalis*, mature female. Agassiz Laboratory, Newport, Rhode Island, August, 1892.

Fig. 5. *Nemopsis bachei*. One of the median marginal tentacles of the medusa shown in figure 6.

Fig. 6. *Nemopsis bachei*, mature male. Hampton Roads, Virginia, November 1, 1904.

Fig. 7. *Bougainvillia carolinensis*, mature male. Charleston Harbor, South Carolina, September 10, 1897.

Fig. 8. *Bougainvillia britannica*, mature female. Eastport, Maine, September 19, 1898.

Drawn from life, by the author.

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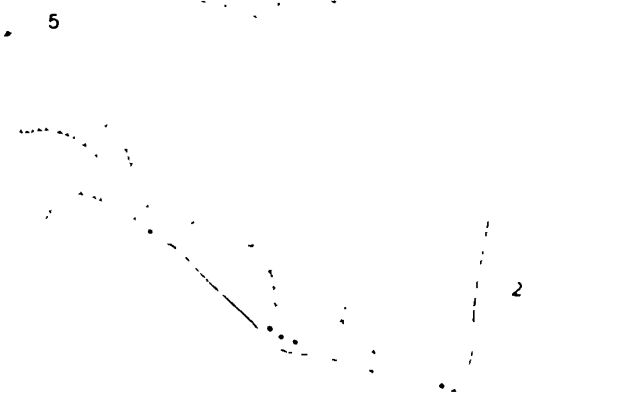
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The mature medusa is described by Maas, Dr. Agassiz and his assistant having found only immature specimens.

*Mature medusa.*—Bell 8 to 14 mm. high, with thick, vertical sides and flatly rounded top, 4 radially placed clusters of marginal tentacles with about 15 to 20 tentacles in each cluster. These tentacles are not half as long as the bell-height and are clavate and flexible. There is an ocellus on the velar (inner) side of the base of each tentacle. There are 4 straight radial-canals which widen as they join the 4 corners of the stomach. The manubrium is wide at its base and lacks a peduncle. It is about half as long as the bell-height. The 4 oral tentacles branch dichotomously 8 times, and their tips end in knob-like expansions, armed with bristling nematocysts. There are thus 256 tips to the oral tentacles in each quadrant.

There are 8 gonads, 2 upon each interradial side of the stomach. These gonads are distinctly separated in the 4 principal radii.

The entoderm of the stomach and tentacle-bulbs is orange-yellow or yellowish-green to brownish-yellow. The gonads are dark-yellow to brown. This medusa is abundant over the western parts of the tropical Pacific, Fiji, Ellice Islands, Malay Archipelago West Coast of Mexico, Acapulco Harbor.

### Bougainvillia britannica Forbes.

Plate 17, fig. 8.

*Hippocrene britannica*, Forbes, 1841, Annals and Mag. Nat. Hist., vol. 7, p. 84, plate 1, fig. 2.
*Bougainvillea britannica*, Forbes, 1848, British Naked-eyed Medusæ, p. 62, plate 12, fig. 1.
*Eudendrium ramosum*, Van Beneden, 1844, Mém. Acad. Belgique, tome 17, p. 56, planche 4; 1866, Fauna Littor. Belgique, p. 112, plates 6, 7.
*Bougainvillea ramosa*, Allman, 1871, Monog. Tub. Hydr., p. 311, plate 9, figs. 5-7 (hydroid and medusa).—Boehm, 1878, Jena. Zeitsch. für Naturw., Bd. 12, p. 189, taf. 6, fig. 6.
*Margelis ramosa*, Haeckel, 1879, Syst. der Medusen, p. 88.
(?) *Lizusa octocilia* (young medusa), Haeckel, *Ibid.*, p. 80.
*Bougainvillia ramosa*, Weismann, 1883, Entstehung Sexualzellen bei Hydromedusen, Jena, pp. 113, 218.—Billard, 1906, Bull. Mus. Hist. Nat. Paris, No. 5, p. 330.
(?) *Bougainvillia ramosa*, Pictet, 1893, Revue Suisse Zool., tome 1, p. 11 (hydroid from Amboina, Malay Archipelago).
*Lizusa octocilia* Dalyell = *Bougainvillia ramosa* Böhm, Hartlaub, 1894, Wissen. Meeresuntersuch. Komm. Meere Kiel, Helgoland, Neue Folge, Bd. 1, p. 190.
*Margelis britannica* (Forbes), Browne, 1895, Trans. Liverpool Biol. Soc., vol. 9, p. 267.
*Bougainvillia ramosa*, Browne, 1898, Journ. Marine Biol. Assoc., N. S., vol. 5, p. 187 (hydroid).
*Margelis ramosa*, Bedot, 1905, Revue Suisse de Zool., tome 13, p. 138 (citation of papers to 1850).
*Margelis britannica*, Browne, 1905, Proc. Roy. Soc. Edinburgh, vol. 25, p. 754.
*Bougainvillia benedenii*, Bonnevie, 1898, Zeit. für wissen. Zool., Bd. 63, p. 484, taf. 26, figs. 34, 35 (degenerating hydroid).
(?) *Bougainvillia obscura*, Bonnevie, 1898, Bergens Museums Aarbog, No. 5, p. 7 (perisarc unringed, 15 tentacles of various lengths).
*Bougainvillia bella*, Hartlaub, 1897, Wissen. Meeresuntersuch. Kommis. Meere Kiel, Helgoland, Neue Folge, Bd. 2, p. 470, taf. 15, fig. 7; taf. 16*a*, figs. 6, 11 = *B. britannica*, Forbes, Hartlaub, 1904, *Ibid.*, Bd. 5, p. 103.
(? ?) *Bougainvillia muscus*, Thornely, 1900, Zoological Results, A. Willey, Part 4, p. 452 (hydroid from tropical Pacific).

Bell about 12 mm. high and 10 mm. wide. High, dome-like, rounded, with very thick walls. Each of the 4 radially placed, marginal tentacle-bulbs gives rise to 16 to 24 short tentacles, about one-fourth as long as the bell-diameter. Each tentacle is provided with a basal ocellus on its inner (velar) side. The ocelli are black in the adult, but may be red in the young medusa.

4 quite wide radial-canals. Manubrium short and wide without a peduncle. The 4 oral tentacles branch dichotomously 6 to 7 times. There are 8 adradial gonads in the ectoderm on the sides of the stomach. The ripe eggs are not inclosed in nematocyst capsules

*Distinctions between B. britannica and B. superciliaris.*

| | Marginal tentacles in each of the 4 radial clusters. | Character of stomach. | Character of gonads. | Color. | Length of marginal tentacles in terms of bell-radius (*r*). |
|---|---|---|---|---|---|
| B. superciliaris L. Agassiz. | 10 to 15 | Mounted on short, 4-sided, prismatic peduncle. | 4 wide interradial. The eggs develop into planulæ on sides of stomach. | Rosin-yellow to reddish-brown. | 1.5 to 2*r* |
| B. britannica Forbes. | 16 to 24 | No peduncle. | 8 narrow adradial. No planulæ on sides of stomach. | Golden-yellow. | 0.5*r* |

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and do not develop into planulæ while still attached to the medusa. The entoderm of the stomach and tentacle-bulbs is golden-yellow. This species is found off the North Atlantic coasts of France, Great Britain, and Germany. It was taken by Hartlaub at Helgoland, German Ocean, in June, and by Browne in the Firth of Clyde, Scotland, in June and July. I found a single mature specimen in the harbor of Eastport, Maine, on September 19, 1898. It appears, therefore, to be widely distributed over the North Atlantic. Pictet, 1893, states that he identifies the hydroid of this form from Amboina, Malay Archipelago.

FIG. 86.—Hydroid of *Bougainvillia britannica*, after Allman, in Ray Society, 1871-72.

The hydroid of *B. britannica* has been commonly called *B. ramosum*, and has been well described by Van Beneden and Allman. The stems are much branched and are 25 to 75 mm. high; the ultimate branches are for the most part alternate. The hydrorhiza is branched and root-like, the branches not anastomosing. The perisarc of the stems exhibits shallow annulations at the origin of the branches. The perisarc extends in a cup-like form over the sides of the hydranths almost to the bases of the tentacles, so that the hydranth may be almost completely withdrawn into the hollow of the cup. There are about 12 tentacles which are filiform and not very long and arise in a single zone at the base of the conical hypostome. The tentacles are carried nearly straight, with every alternate one elevated and depressed. The medusa-buds are borne singly on moderately long pedicels which arise from the bases of the hydranths upon the terminal branches of the stems. There are 1 to 2 medusa-buds at the base of each hydranth. When set free the medusa has a bell higher than a hemisphere, with fairly thick walls. There are 8 marginal tentacles, 2 in each radial cluster, and 4 short-knobbed, oral tentacles. Browne, 1898, had a hydroid of this species from the Eddystone, English Channel, which liberated 4,450 medusæ in 3 days.

Wiesman, 1883, finds that the germ-cells of both sexes originate in the ectoderm of the manubrium of the budding medusa and they do not wander from their place of origin, but remain there and become mature in the free-swimming medusa.

### Bougainvillia superciliaris L. Agassiz.

Plate 17, fig. 1.

*Hippocrene bougainvillii*, GOULD, 1841, Report on Invertebrates of Massachusetts, p. 348.

*Hippocrene superciliaris*, AGASSIZ, L., 1849, Mem. Amer. Acad., New Series, vol. 4, p. 250, plates 1-3, 53 figs.—STIMPSON, 1853, Maine Invert. Grand Manan, p. 11.

*Bougainvillia superciliaris*, AGASSIZ, L., 1862, Cont. Nat. Hist. U. S., vol. 4, pp. 289, 291, figs. 37-39; p. 344, plate 27, figs. 1-7.—AGASSIZ, A., 1862, Proc. Boston Soc. Nat. Hist., vol. 9, p. 97, figs. 24, 25; 1865, North Amer. Acal., p. 153, figs. 232-240.—VERRILL, 1873, Report Commiss. Fish and Fisheries U. S., for 1871-72, pp. 328, 733, plate 37, fig. 276.

*Hippocrene superciliaris*, HAECKEL, 1879, Syst. der Medusen, p. 92.

*Bougainvillea superciliaris*, WAGNER, 1885, Wirbellosen des Weissen Meeres, p. 73, taf. 2, fign. 5, 8, 9; *non* 6, 7.—LEVINSEN, 1893, Vid. Meddel. Nat. For. Kjöbenhavn, ser. 5, Bd. 4, p. 144.—MAAS, 1893, Ergeb. der Plankton Exped., Bd. 2, K. c., p. 69.—HARTLAUB, 1897, Wissen. Meeresuntersuch. auf Helgoland, Heft. 1, Abt. 2, p. 466, taf. XVI*a*, fign. 1, 5, 7-9, 12; taf. XVI*b*, fig. 3; taf. XVI*c*, fign. 3, 4, 11-13; taf. XV, fig. 1.

*Hippocrene superciliaris*, SCHLATER, 1891, Révue des Sci. Naturelles, St. Pétersbourg, tome 2, p. 342.—BIRULA, 1896, Annuaire du Mus. Zool. de l'Acad. Impériale des Sci., St. Pétersbourg, tome 1, No. 4, pp. 330, 339.—GRÖNBERG, 1898, Zoolog. Jahrb., Abth. Syst., Bd. 11, p. 462, taf. 27, fign. 5, 6.

*Hippocrene superciliaris* + *H. aurea*, LINKO, 1904, Zool. Anzeiger, Bd. 28, p. 216; 1900, Mém. Acad. Sci. St. Pétersbourg, sér. 8, tome 10, No. 3, p. 6, taf. 1, fign. 13-18, taf. 2, fign. 19-21 (histology of the ocelli).

*Bougainvillia superciliaris*, HARGITT, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 40, 1 fig.

*Bougainvillia superciliaris*, NUTTING, 1901, Bull. U. S. Fish Commission, vol. 19, pp. 330, 376, fig. 90.

*Bougainvillea paradoxica*, MERESCHKOWSKY, 1879, Annals and Mag. Nat. Hist., ser. 5, vol. 3, p. 177, plate 20.

(?) *Hippocrene bougainvillii*, BRANDT, 1834, Récueil Actes séances publiques Acad. Imp. Sci. St. Pétersbourg, p. 29 (of the "separate"); 1853, Mém. Acad. Imp. Sci. St. Pétersbourg, sér. 6, vol. 4, part 2, p. 393, plate 20 = *Bougainvillea mertensii*, L. Agassiz, 1862.

*Adult medusa.*—Bell about 10 mm. in height and about same in diameter. Gelatinous substance very thick, so that bell-cavity is only about half as deep as the bell-height. There are 4 clusters of marginal tentacles which are situated at the bases of the 4 radial-canals.

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Each cluster of tentacles arises from a large bulbous swelling upon the bell-margin. There are 10 to 15 tentacles in each cluster. The tentacles are highly contractile and are normally about two-thirds as long as the bell-diameter. There is a single, very dark-brown ocellus within the ectoderm of the inner (velar) side of the base of each tentacle. The velum is well developed. There are 4 straight, narrow radial-canals, which arise from the 4 radial corners of the stomach. The stomach is wide and quadratic in cross-section and flask-shaped in longitudinal outline. It is mounted upon a 4-sided peduncle which is about half as long as the stomach itself. There are 4 radially situated, oral tentacles, each of which branches dichotomously about 5 times. The mouth is situated at the extremity of a short, simple tube and the lips are not prominent. The mature genital products are situated within the ectoderm of the 4 interradial sides of the stomach. There are thus 4 interradial gonads, above the zone of the oral tentacles. This species is thus separated from *B. bella* by having 4 interradial instead of 8 adradial gonads. In the female, according to Hartlaub, 1897, the large eggs may be seen lying within the ectoderm close to the supporting lamella. As they grow larger they approach the surface, and finally become inclosed in epithelial, nematocyst-bearing capsules, derived from the ectoderm cells of the stomach-wall. These capsules finally protrude from the sides of the manubrium, but each one remains attached to it by a narrow stalk. In this situation the egg develops into a planula which finally breaks through the walls of the capsule and escapes into the water. Hartlaub showed that although the large eggs were found in the ectoderm they were derived from the entoderm of the young medusa. In the young and immature medusa the supporting lamella does not completely separate the ectoderm from the entoderm, and the egg-cells then migrate from the entoderm into the ectoderm (see Hartlaub, 1897, pp. 469–470).* The sperm originates in the ectoderm and there develops without migration.

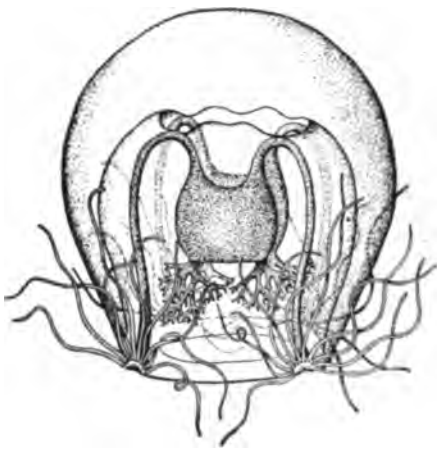

FIG. 87.—*Bougainvillia superciliaris*, after L. Agassiz in Mem. Amer. Acad. Arts and Sci., 1849. Side view of medusa.

The entoderm of the manubrium and tentacle-bulbs is rosin-yellow or reddish-brown, and the gelatinous substance of the bell often has a decided yellowish tinge.

*Hydroid and young medusa.*—The hydroid is usually found attached to rocks, and lives in the purest sea-water. It grows in clusters, not more than 50 mm. high. The stems give rise to primary and secondary branches, which arise somewhat irregularly, though more or less alternately and spirally. The base of every branch is ringed with from 5 to 10 annulations. The chitinous sheath which incloses the stem thins out as it passes on to the polypites and disappears entirely below the circlet of tentacles. Each polypite has from 15 to 20 long, slender tentacles which arise from a single circlet near the distal end of the polypite. Each tentacle is ringed at regular intervals by clusters of nematocyst-cells. The medusa-buds arise singly and somewhat irregularly from the sides of the stem, near the proximal bases of the polypites. Each medusa-bud is inclosed in a thin capsule formed from the chitinous ectosarc of the stem. When set free the young medusa usually has 8 marginal tentacles, 2 at the base of each radial tube. The young tentacles are each provided with a centripetal, ectodermal ocellus. The manubrium is short and tubular and there are 4 short, knob-shaped, unbranched, oral tentacles.

In common with other Arctic medusæ this species appears upon the southern coast of New England early in April and soon disappears. It is found throughout the summer, however, north of Cape Cod, and mature individuals are occasionally taken at Eastport, Maine, in August. This species has been found by Levinsen, 1893, off the west coast of Greenland, and according to Birula, 1896, it is the most abundant medusa in the White Sea in July. Hartlaub, 1897, found it at Helgoland, and Linko, 1904, found it in Barents Sea,

* It is interesting to observe that other species of the Bougainvillidi, such as *Cytaeis*, also retain the embryos within the ectoderm of the manubrium until the planula stage. This was first observed by Mereschowsky, 1879, and has since been confirmed by N. Wagner, 1885, and by Hartlaub, 1897.

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where it commonly occurs in the fjords from November until June, but during the summer it is found about a degree northward of Ekaterinen Harbor, in the cold water. At Helgoland the medusa is most abundant in February and March.

"*Hippocrene aurea*" Linko is only an Arctic form of *Bougainvillia superciliaris* in which the oral tentacles branch dichotomously 7 times, instead of 5 to 6 times as is commonly observed.

I am inclined to believe that *Hippocrene bougainvillii* Brandt (=*Bougainvillea mertensii* L. Agassiz) from Behrings Sea is identical with *B. superciliaris*.

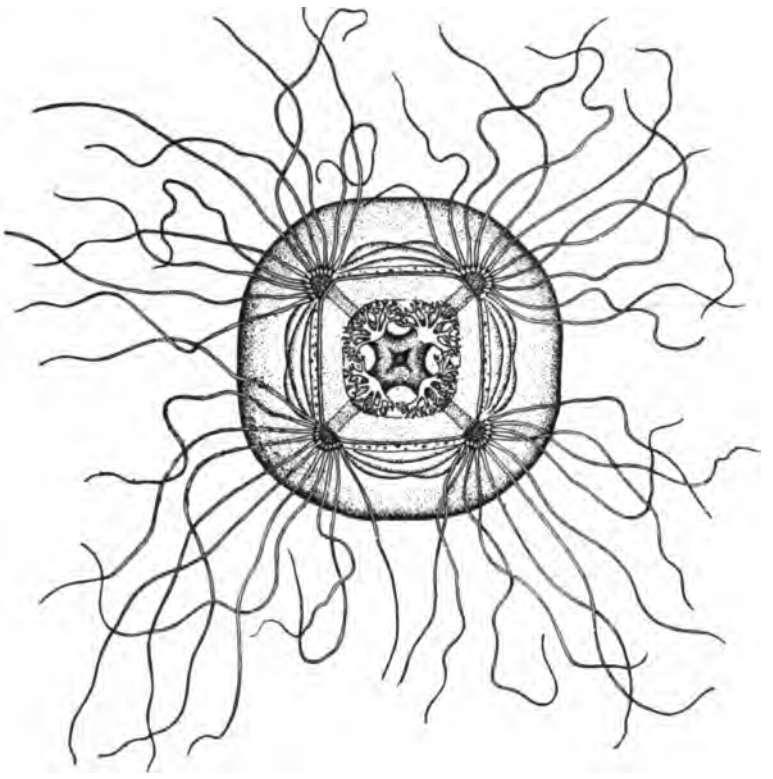

FIG. 88.—*Bougainvillia superciliaris*, after L. Agassiz in Mem. Amer. Acad. Arts and Sci., 1849. Oral view of medusa.

**Bougainvillia dinema=B. superciliaris (?).**

*Bougainvillea dinema*, GREENE, 1857, Nat. Hist. Review, vol. 4, p. 246, plate 15, fig. 6.
*Margelis zygonema*, HAECKEL, 1880, Syst. der Medusen, p. 635.

I believe this medusa to be identical with *B. superciliaris*. (See tabular synopsis.)

Bell oval with a constricted margin, 10 to 12 mm. high, 6 to 8 mm. wide. The 4 marginal tentacle-bulbs are kidney-shaped and only half as wide as the intervals between them. Each bulb bears 10 to 12 ocelli. Only 2 tentacles were observed by Greene and Haeckel on each bulb, but the others had probably been broken off. The 2 were at the ends of the bulb.

The stomach is roundish, 4-sided, smaller than the tentacle-bulbs, and hardly one-fourth as long as the bell-height. The 4 oral tentacles branch dichotomously 4 or 5 times. The gonads are 4 interradial, triangular to egg-shaped swellings on the sides of the stomach. Stomach, gonads, and tentacle-bulbs yellow.

East coast of Ireland.

**Bougainvillia multicilia.**

*Lizusa multicilia*, HAECKEL, 1879, Syst. der Medusen, p. 81, taf. 6, fig. 13.

Bell three-fourths spherical, with thin, uniform walls, evenly rounded, 6 mm. high, 5 mm. wide. 4 wide, kidney-shaped, marginal tentacle-bulbs, wider than the intervals between them; each with 10 to 12 tentacles with ocelli, and about as long as the bell-radius. 4 straight,

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narrow radial-canals. The velum is narrow. The stomach is globular with a constricted base, but no peduncle. 4 simple, unbranched oral tentacles, each ending in a single nematocyst-knob. 4 pairs of gonads on the adradial sides of the stomach. Stomach light-yellow. Gonads and tentacle-bulbs orange-yellow. Ocelli dark-red. Straits of Gibraltar in March. This may be a young form, the shape of the bell and unbranched condition of the oral tentacles being indications of immaturity.

**Bougainvillia platygaster.**

*Hippocrene platygaster*, HAECKEL, 1879, Syst. der Medusen, p. 91.

Bell cubical, flat above. 12 mm. high, 12 mm. wide. The 4 radially placed, marginal tentacle clusters arise from wide, triangular, basal swellings, which are wider than the interradial spaces between them. Each basal swelling gives rise to 10 to 12 tentacles, which are shorter than the bell-diameter. The tentacles arise in a single row from their basal bulbs. Ocelli (?) Stomach flat and 4-sided. It is 4 times as wide as high, and without a peduncle. The 4 short, oral tentacles branch dichotomously 3 or 4 times, giving 8 to 16 short, terminal ramuli in each quadrant. The 4 wide, rectangular gonads are on the interradial sides of the stomach. The stomach, gonads, and tentacle-bulbs are reddish-yellow.

Atlantic Ocean, Cape Verde, and Canary Islands.

Distinguished by the wide, triangular, basal bulbs of its marginal tentacles, and its short, wide, 4-sided stomach.

**Bougainvillia xantha Hartlaub.**

*Bougainvillia xantha*, HARTLAUB, 1897, Wissen. Meeresuntersuch. Kommis., Meere Kiel, Helgoland, Neue Folge, Bd. 2, p. 461, taf. 15, figs. 2, 3; taf. 16*a*, fig. 3; taf. 16*b*, fig. 19.

*Young medusa*.—Bell rounded, somewhat higher than wide, with thick gelatinous walls. Height 4 or 5 mm. Bell-margin 4-sided. Each of the 4 radially situated, marginal tentacle-bulbs gives rise to 9 or 10 tentacles, with small, indifferently developed, brownish-violet ocelli. 4 quite wide radial-canals. Manubrium small, with 4 branching oral tentacles longer than the manubrium. The oral tentacles branch dichotomously about 4 times and each ends in about 16 nematocyst-knobs. These terminal branches of the oral tentacles are very short in comparison with the length of the main shaft of the tentacle. The 4 interradial gonads begin to develop in specimens about 4 mm. wide. The tentacle-bulbs and stomach are light golden-yellow to reddish in color. The interradial entodermal lamella is translucent greenish-yellow. Common at Helgoland from March until the end of June. No mature specimens have been seen and the hydroid is unknown. It is closely allied to *B. flavida* and may be only a variety of the latter form. It appears, however, to have more marginal tentacles in corresponding stages of growth than is seen in *B. flavida* and there are slight color differences.

**Bougainvillia carolinensis Allman.**

Plate 16, figs. 7 to 9; plate 17, fig. 7.

*Hippocrene carolinensis*, MCCRADY, 1857, Gymn. Charleston Harbor, p. 62, plate 10, figs. 8-10.
*Margelis carolinensis*, AGASSIZ, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 344. AGASSIZ, A., 1865, North Amer. Acal., p. 156, figs. 241-248. HAECKEL, 1879, Syst. der Medusen, p. 89.
*Bougainvillia carolinensis*, ALLMAN, 1871, Monog. Tubul. Hydroids, p. 316.
*Bougainvillia carolinensis*, NUTTING, 1901, Bull. U. S. Fish Commission for 1899, vol. 19, pp. 330, 376; figs. 5, 89. HARGITT, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 39, plate 2, fig. 4; 1901, American Naturalist, vol. 35, p. 583, fig. 46.

*Adult medusa* (plate 17, fig. 7).—Bell dome-shaped and 4 mm. in height. Bell-walls, especially at apex, very thick. There are 4 radially arranged clusters of marginal tentacles that arise from 4 small, bulbous, basal swellings. 7 to 9 tentacles in each cluster. The longest of these tentacles attain a length about equal to the bell-height. The tentacles are slender and quite stiff, and their tips are usually curled downwards in a semicircle. A large ectodermal ocellus is situated at the base of each tentacle upon the ventral (centripetal) side. The velum is well developed. There are 4 straight, narrow, radial tubes. The manubrium is long and narrow, and extends for about half the distance from the inner apex of the bell-cavity to the velar opening. Near its distal end it is somewhat wider than at its base. The mouth part, however, is a simple, narrow tube. 4 oral tentacles arise from the 4 radial sides

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of the mouth-part of the manubrium. Each one of these branches twice dichotomously, thus giving rise to 4 tentacle tips in each quadrant. The gonads are found in the ectoderm of the manubrium, where they occupy longitudinal, interradially situated, swollen regions.

In the Tortugas and Charleston Harbor examples of this species, the entoderm of the tentacle-bulbs and of the manubrium is of a delicate sage-green. The gonads are cream-colored, and the tentacular ocelli dark-brown or black. In northern examples of this medusa, found at Newport, Rhode Island, and Naushon, Massachusetts, according to A. Agassiz, the tentacle-bulbs are colored with brilliant red, surrounded by a green edge bordered with bright-yellow, and the digestive cavity is brick-red or green. No such brilliant coloration has been observed by me in southern examples of this species.

The hydroid stock has been figured by A. Agassiz, 1865, p. 158. It occurs very commonly upon *Fucus vesiculosus*, where it grows in dense clusters. The main stems are often 230 to 270 mm. in length. They taper gradually from base to summit and branch profusely and pinnately. The side branches do not often give rise to secondary branches. Great numbers of ringed pedicels, which terminate in polyp-heads, arise from the sides of the main stem and also from the branches. The polypites are fusiform and possess a single circlet of about 15 long, slender tentacles near the distal extremity. The mouth is situated at the apex of a slight, conical proboscis. Medusa-buds make their appearance anywhere all over the stems, where they appear either singly or in clusters. When set free the young medusa is about 1.7 mm. in height. The bell is pyriform in outline, and the gelatinous substance quite thick. There are 8 tentacles, 2 at the base of each of the 4 radial tubes. The tentacles are all provided with basal ocelli. The manubrium is small, slender, and tubular, and there are 4 short, unbranched, oral tentacles.

The general color of the stems of the hydroid is of a horny green and the polypites are often of a delicate rosy tint.

This medusa is very abundant throughout the summer in Charleston Harbor, South Carolina. It is much rarer at the Tortugas, Florida. The brilliantly colored, northern variety is said to be quite common upon the southern coast of New England, but it has never been found north of Cape Cod, Massachusetts.

Hargitt, 1901 (Biol. Bulletin, Woods Hole, vol. 2, p. 228), discovered a remarkable twin sport, apparently of this medusa. It had 2 manubria fused at a common base so as to form a common stomach. Each "twin" had a complete bell-margin, only the sides of their bells being fused one to the other.

### Bougainvillia niobe Mayer.

Plate 18, figs. 1–3.

*Bougainvillia niobe*, MAYER, 1894, Bull. Mus. Comp. Zool. at Harvard College, vol. 25, p. 236, plate 1, fig. 2; *Ibid.*, vol. 37, p. 42; 1904, Mem. Nat. Sci. Brooklyn Institute Museum, vol. 1, p. 11, plate 2, figs. 14–15c.

*Adult medusa* (plate 18, fig. 1).—Bell 6.75 mm. high and 4.8 mm. in diameter, with vertical sides and thick, gelatinous walls. 4 radially situated clusters of marginal tentacles, each composed of about 8 tentacles about as long as the bell-height. On the velar side of each tentacle, near the bulbous base, there is a dark-colored ocellus. 4 straight, narrow radial-canals. Manubrium wide, flask-shaped, and cruciform in cross-section. About half as long as the height of the bell-cavity. 4 radially situated clusters of oral tentacles, each of which branches dichotomously 4 times. These are very flexible and their distal ends are knobbed.

Medusa-buds arise from the 8 adradii of the manubrium, the youngest buds being immediately under and on both sides of the point of entrance of each radial-canal, while older ones are found farther down the sides of the stomach. The young buds are small, ovoid vesicles contained entirely in the ectoderm. The limiting membrane, between the entoderm and ectoderm of the manubrium in the neighborhood of these buds, is entire (plate 18, fig. 3), and I can find no evidence of cells passing through it. Indeed, throughout the future development of the buds, the entoderm remains inert and its limiting membrane unbroken. The wall of the vesicle consists of 2 layers of cells: an outer epithelium of ectodermal cells, destined to give rise to the ectoderm of the bud, and an inner layer of somewhat larger cells destined to give rise to the entoderm of the budding medusa (plate 18, fig. 2). These latter cells are entirely incased by the ectoderm of the parent. They may, however, have been

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## Plate 18.

Fig. 1. *Bougainvillia niobe*, Nassau Harbor, Bahamas, March 18, 1893.

Fig. 2. *Bougainvillia niobe*, section of a young medusa-bud upon the ectoderm of the manubrium. *c*, central mass of degenerating cells; *e c t*, ectoderm of the manubrium of the parent medusa; *e n t*, (brown) entoderm of the parent medusa; *e c t b*, (gray) ectoderm of the budding medusa; *e n t b*, (green) entoderm of the budding medusa; *s l*, limiting membrane between the ectoderm and entoderm of the manubrium of the parent medusa.

Fig. 3. *Bougainvillia niobe*. Cross-section of the medusa showing the budding region of the manubrium. Successive stages in development of buds are shown in b1–b4. Colors as in figure 2.

Fig. 4. *Rathkea elegans*, mature male. Tortugas, Florida, July 1, 1899.

Fig. 5. *Rathkea octopunctata* var. *grata*. Newport Harbor, Rhode Island, April 24, 1897.

Drawn by the author from living and preserved specimens.

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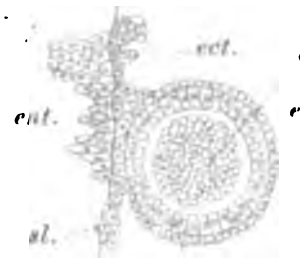


*ent. b.*

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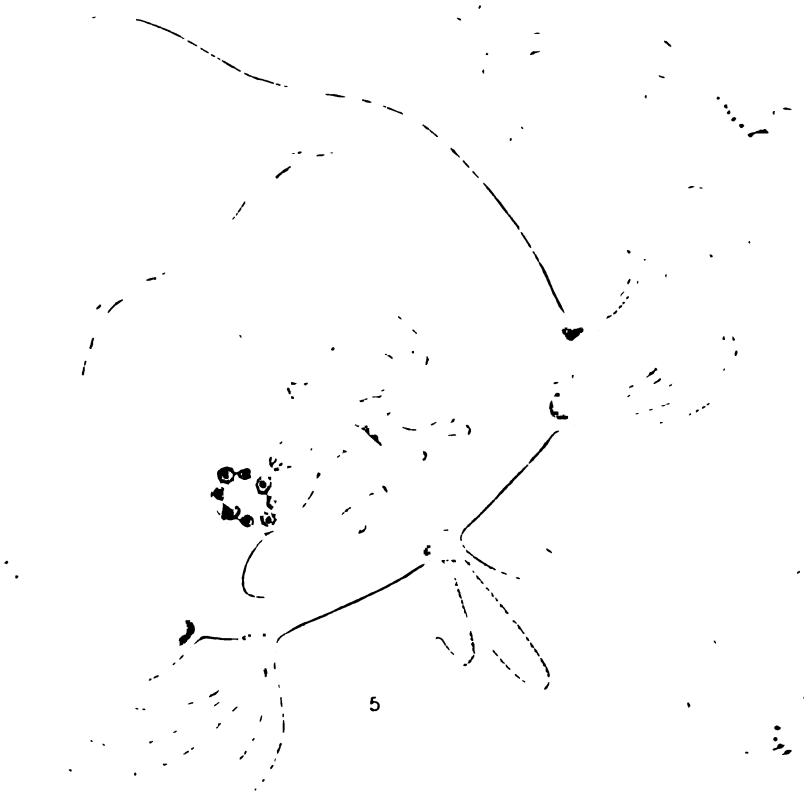


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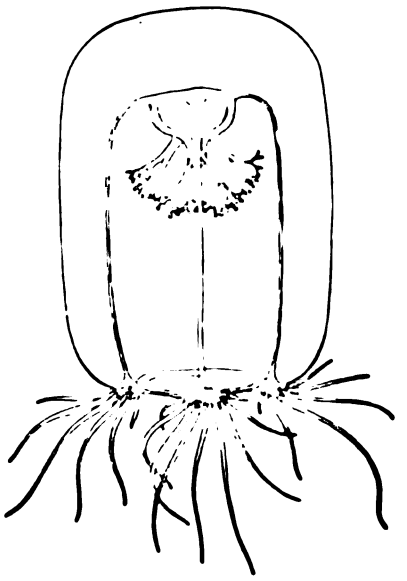
derived at an earlier stage from the entoderm of the parent medusa and have migrated into the ectoderm. Careful search has, however, failed to reveal evidence of any such migration, and in default of evidence to the contrary, we assume that these cells *may* be ectodermal in origin, although destined to produce the entoderm of the bud.

The central cavity of the vesicle is partially filled with a loose mass of nuclei and cell material showing little or no trace of cell boundaries (*c*, plate 18, fig. 2). These are present at all stages of the developing bud, partially filling the gastrovascular cavity, but they appear to degenerate in later stages, and it seems possible they serve to nourish the bud in its growth. This supposition appears the more probable from the fact that the gastrovascular cavity of the bud is never in connection with that of the parent medusa.

We have, therefore, a graded series of phenomena in the asexual production of medusa-buds by hydromedusæ. Where the ectoderm and entoderm are both thin-layered and of about equal thickness, such as in *Sarsia* and *Eucheilota paradoxica*, both entoderm and ectoderm take an equal share in the formation of the bud. In forms such as *Rathkea octopunctata* and

89.

89.



90.

FIG. 89.—Hydroid of *Bougainvillia carolinensis*, after A. Agassiz, in North American Acalephæ, showing an enlarged view of a part of stem bearing medusa-buds.
FIG. 90.—*Bougainvillia niobe*, from life, by the author. Tortugas, Florida, June 27, 1908.

*Lizzia claparedei*, according to Chun, Bibliotheca Zoologica, 1895, a different condition is observed, for the medusa-buds are formed entirely within the ectoderm of the parent, although the gastrovascular cavity of the bud finally acquires a connection with that of the parent, the entoderm of the bud becoming continuous with that of the parent manubrium.

In *Bougainvillia niobe*, however, the ectoderm is very thick and the budding medusæ are developed within it alone, the entoderm of the parent medusa remaining inert and passive during the growth of the bud, and no connection ever being established between the gastrovascular cavities of the bud and the parent. This result may be regarded as due to a gradual process favored by the thickness of the ectoderm, which prevented the deep-lying entoderm from taking an equal share in the formation of the bud, until finally it remains passive throughout the period of the formation of the bud. Medusæ produced from ectoderm alone may, therefore, be phylogenetically homologous with medusæ produced by the more primitive and universal cooperation of both ectoderm and entoderm.

The entoderm of the manubrium and tentacle-bulbs of *B. niobe* is rosin-colored, all other parts being transparent. There is a dark-colored ocellus on the velar side of each tentacle near the basal bulb. This medusa is found in Nassau Harbor, Bahamas, in April.

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**Bougainvillia pyramidata.**

*Hippocrene pyramidata*, FORBES AND GOODSIR, 1853, Trans. Roy. Soc. Edinburgh, vol. 20, p. 312, plate 10, fig. 4.—HAECKEL, 1880, Syst. der Medusen, p. 635.—BROWNE, 1905, Proc. Roy. Soc. Edinburgh, vol. 25, p. 751.

Bell semiglobular, 2.5 to 6 mm. wide and equally high. Bell-walls thick and gelatinous substance at apex well developed. The 4 marginal tentacle-bulbs are very small and globular, and each one bears 6 to 8 tentacles which have ocelli and are somewhat shorter than the bell-diameter. The stomach is mounted upon a short, conical peduncle. It is cruciform and its 4 lobes extend along the entire length of the peduncle. The mouth is a circular opening. The 4 oral tentacles branch twice dichotomously. The gonads are upon the basal margin of the stomach and its lobes. The radial-canals are straight and narrow. Stomach, gonads, and tentacle-bulbs orange-yellow to reddish-brown. Tentacular ocelli black. Found off the west coast of Scotland and off the south coast of Ireland.

**Bougainvillia nordgaardii.**

*Margelis nordgaardii*, BROWNE, 1903, Bergens Museums Aarbog, No. 4, p. 14, plate 2, fig. 1, plate 3, figs. 5, 6.

Bell 4 mm. wide, 4 mm. high. Bell-walls uniform and of moderate thickness. Bell dome-like, evenly rounded. 5 to 7 tentacles in each of the 4 radial bulbs. No ocelli. Tentacles somewhat longer than the bell-diameter. Velum narrow. Stomach half as long as the depth of the bell-cavity. 4 oral tentacles, 4 or 5 times dichotomously branched. 4 wide, interradial, gonads on the sides of the stomach. Gonads and tentacle-bulbs yellowish-brown (in formalin). Byfjord, near Bergen, Norway. Distinguished by its lack of ocelli.

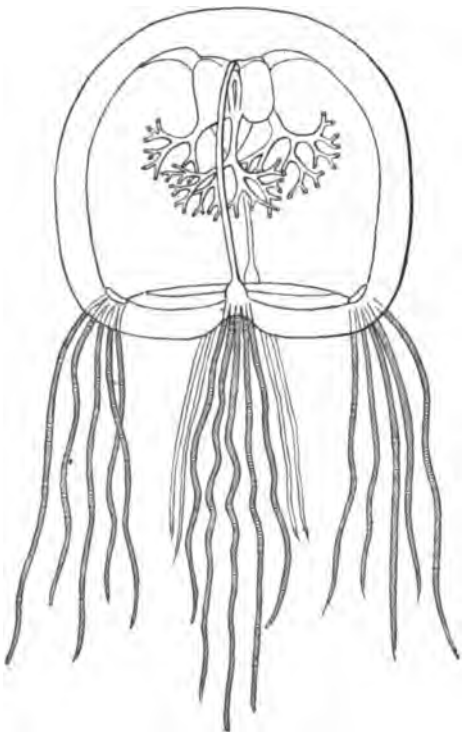

FIG. 91. -*Bougainvillia nordgaardii*, after Browne, in Bergens Museums Aarbog, 1903.

For details see tabular synopsis of medusæ of *Bougainvillia*.

**Bougainvillia flavida Hartlaub.**

*Bougainvillia flavida*, HARTLAUB, 1897, Wissen. Meeresuntersuch. Kommis. Deutsch. Meere Kiel, Helgoland, Neue Folge, Bd. 1, p. 456, taf. 14, figs. 1–10; taf. 15, figs. 4–6, 8.

The mature medusa is slightly higher than a hemisphere with an evenly-rounded bell. The gelatinous substance is thick, so that the bell-cavity is only a little more than half as deep as the bell-height. The bell is 2 or 3 mm. wide. There are 4 radially placed clusters of marginal tentacles with not more than 6 tentacles in each cluster. These tentacles are about as long as the bell-diameter and each one has a large ocellus upon its velar side near the base of the cluster. The 4 common, basal bulbs are swollen, semiglobular, and well developed. 4 quite wide, straight radial-canals and a narrow, simple, circular vessel. Manubrium small, conical, half as long as the depth of the bell-cavity. Without a peduncle. The 4 oral tentacles branch dichotomously about 3 times. With interradial, undivided gonads. Entoderm of manubrium and tentacle-bases orange-yellow.

The mature medusæ are found at Helgoland, German Ocean, in August and September.

*Hydroid.*—The hydrorhiza is net-like, creeping, and yellowish-brown in color. The stems arise at quite infrequent intervals and are unbranched, very slender below and swollen above at the polypite. They are 5 to 7 mm. high and light gray-brown in color. The hydranths are elongate, club-shaped, with 8 to 10 tentacles in a single zone around the mouth. The medusa-buds are produced upon branching processes which arise from the sides of the stem near the base of the polypite, or from points lower down upon the side of the polypite

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itself. There may be as many as 6 medusa-buds upon one of these branches, and there are usually several branches producing medusæ. The buds are oval at first, but later they become spherical.

When set free the medusa's bell is only 0.3 to 0.6 mm. wide. It is irregularly globular with very thick walls and an irregularly shaped bell-cavity. There are 4 perradial basal bulbs, each of which gives rise to a single, marginal tentacle. These are long and lack ocelli. 4 simple, unbranched, oral tentacles, and 4 wide radial-canals, with an axial canal above the stomach. The exumbrella is besprinkled with nematocysts as is usual in young medusæ. The tentacle-bulbs and manubrium are reddish-brown by reflected light.

The hydroid is found at Helgoland attached to living or dead shells during the summer. Both hydroid and medusa are described in detail by Hartlaub, 1897.

### Bougainvillia autumnalis Hartlaub.

Plate 16, figs. 4 and 5; plate 17, figs. 3 and 4.

EUROPEAN MEDUSA.

*Bougainvillia autumnalis*, HARTLAUB, 1897, Wissen. Meeresuntersuch. Kommis. Meere Kiel, Helgoland, Neue Folge, Bd. 2, p. 465, taf. 15, fign. 11–13.
*Margelis autumnalis*, BROWNE, 1906, Trans. Linnean Soc. London, ser. 2, Zool., vol. 10, p. 170.

AMERICAN MEDUSA.

*Bougainvillia gibbsi*, MAYER, 1900, Bull. Mus. Comp. Zool. at Harvard College., vol. 37, p. 5, plate 4, figs. 14, 15. –HARGITT, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 40; 1901, American Naturalist, vol. 35, p. 583.

Bell rounded, 2.5 mm. wide, somewhat higher than a hemisphere, with thick, gelatinous walls. 4 bulbous, rounded, marginal tentacle-bulbs, each of which gives rise to 3 to 6 tentacles. 4 narrow, straight radial-canals. Manubrium short, wide, 4-sided, urn-shaped; not half as long as the depth of the bell-cavity. 4 oral tentacles which turn upwards and branch dichotomously 2 to 5 times. The ends of the oral tentacles are simple, without terminal knobs. 4 interradial gonads in the ectoderm of the stomach-wall. Tentacle-bulbs yellowish to greenish-yellow. Manubrium green or brown. Hydroid unknown.

Found by Hartlaub at Helgoland, German Ocean, from the end of August to the end of November. Browne found it off the west coast of Ireland and in the English Channel.

I consider this medusa to be identical with *B. gibbsi* Mayer, of the southern coast of New England. It is possibly separated by uncertain and variable color differences. A description of the American form is herewith presented:

*Adult medusa* (plate 16, fig. 5; plate 17, fig. 4).—Bell about 4 mm. in height and 3.8 mm. in diameter. Gelatinous substance very thick, so that the bell-cavity is only about half as deep as the height of the animal. There are 4 clusters of marginal tentacles which arise from 4 large, bulbous swellings situated at the bases of the 4 radial-canals. Each bulbous swelling gives rise to 4 or 5 slender tentacles. There is a single, dark-brown ocellus at the base of each tentacle upon the centripetal (velar) side. The velum is small. There are 4 straight, narrow radial-canals. The manubrium is wide and cruciform in cross-section, and the radial-canals arise from the 4 corners of the cross. The manubrium is short and does not extend quite half the distance from the inner apex of the bell-cavity to the velar opening. The mouth is situated at the extremity of a short, tubular neck and there are no prominent lips. 4 radially situated, oral tentacles arise from the sides of the neck of the manubrium. Each of these branches dichotomously about twice. The gonads are developed upon the 4 interradial sides of the stomach, and in the female the ova are large and prominent. The manubrium is pearl-colored or of a delicate green. The entodermal cores of the tentacle-bulbs are red, surrounded by a delicate yellow-green. The supporting lamella of the bell often displays a faint greenish tinge.

*Young medusa.*—In the young medusa there are but 8 tentacles, 2 from each tentacle-bulb. The bell is a little higher than a hemisphere and the gelatinous substance is not very thick, being of about uniform thickness everywhere, instead of being very thick at the aboral pole as in the adult. The manubrium is short and quadratic and there are 4 short, unbranched, knob-shaped, oral tentacles. When the medusa is about 3 mm. in height, the bell is still hemispherical. The manubrium is wide, shallow, and quadratic, and the oral tentacles branch once dichotomously. About 3 to 5 marginal tentacles arise from each tentacle-bulb.

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This medusa is found in Newport Harbor, Rhode Island, United States, from July until October. I consider it to be identical with Hartlaub's *B. autumnalis* from Helgoland, German Ocean.

This species is distinguished from *Bougainvillia carolinensis* by the greater height and lesser width of its bell. Also in *B. carolinensis* the manubrium is long and slender, while in *B. autumnalis* it is short and wide. The manubrium of *B. carolinensis* is widest at about the middle of its length, while that of *B. autumnalis* is widest at its proximal base.

### Bougainvillia prolifera.

*Lizusa prolifera*, VON LENDENFELD, 1884, Proc. Linnean Soc. New South Wales, vol. 9, p. 589, plate 23, figs. 38, 39.

Bell evenly rounded, 3 mm. high, 2.5 mm. wide. 4 radial clusters of marginal tentacles which arise from large, "scrota-shaped" basal bulbs; 5 tentacles upon each bulb, 20 in all. These tentacles are about half as long as the height of the bell. 4 simple radial-canals. Stomach small, nearly cubic, with 4 unbranched, simple, oral tentacles about two-thirds as long as the length of the stomach. These end each in knob-like clusters of nematocysts. Medusa-buds develop at the base of the manubrium and these give rise also to medusæ which appear as buds at the time when the originally budding medusæ are set free. Tentacle-bulbs and stomach brown, other parts colorless.

Port Jackson, New South Wales; March to April.

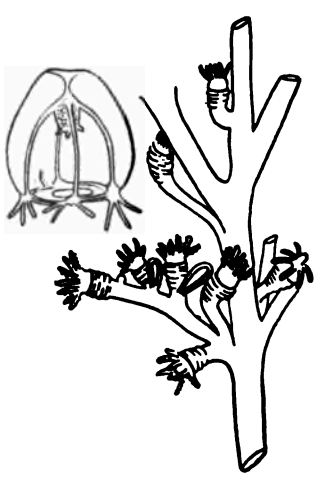
This medusa exhibits every indication of immaturity, and it is probable that the oral tentacles finally become branched.

### Bougainvillia maniculata Haeckel.

*Bougainvillea maniculata*, HAECKEL, 1864, Jena. Zeitsch. für Naturw., Bd. 1, p. 340; 1879, Syst. der Medusen, p. 89, taf. 5, fign. 4, 5.

Bell almost spherical, 1.5 mm. wide, 1.5 mm. high with uniform, fairly thin walls. Velum very wide. The 4 marginal tentacle clusters are hand-shaped; each with 4 very short,

92.



93.

FIG. 92.—*Bougainvillia maniculata*, after Haeckel, 1879.
FIG. 93.—*Bougainvillia rugosa*, after S. F. Clarke, in Mem. Boston Soc. Nat. Hist.

finger-like tentacles, with an ocellus on the inner side of each. The stomach is spherical, with a narrow base, and a long, conical throat-tube which projects beyond the velar opening. There are 4 long, slender, oral tentacles, which branch twice dichotomously at their outer ends, thus ending in 4 very short, knobbed tips. These oral tentacles are each about as long as the manubrium itself.

There are 4 interradial gonads on the sides of the stomach. The stomach, gonads, and tentacle-bulbs are violet-gray. Found by Haeckel in the Mediterranean at Villafranca and Nizza.

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The medusa is distinguished by its thin-walled, almost spherical bell, its wide velum, and its very long oral tentacles which branch only at their outer ends. The flask-shaped stomach and small size are also characteristic. On the whole it presents the appearance of a degenerate form.

### Bougainvillia rugosa Clarke.

Plate 17, fig. 2.

*Bougainvillia rugosa*, CLARKE, 1882, Mem. Boston Soc. Nat. Hist., vol. 3, p. 140, plate 8, figs. 21-24.

*Young medusa* (plate 17, fig. 2).—Umbrella somewhat pyriform. 12 marginal tentacles, 3 at the base of each radial tube. Tentacles all of equal size. According to Clarke, ocelli are developed only at the bases of those 2 tentacles which are first and second as one passes around the bell from left to right, but I found a specimen with 12 ocelli, one at the base of each tentacle. The velum is well developed. There are 4 straight, narrow, radial tubes. The manubrium is short and thick, and there are 4 short, unbranched, oral tentacles.

*Hydroid.*—The hydroid stock attains a height of 75 mm. There are numerous irregularly arranged branches. Some of the branches which arise near the proximal end are about as long as the main stem, but most of them are short and delicate. The branches bear secondary branches which give rise to 3 or 4 terminal ramuli. The hydroid is rooted by a creeping stolon. The polypites are fusiform and are protected by an expansion of the perisarc which bears a number of annulations. There are 8 to 10 short tentacles. The medusa-buds are borne upon the ultimate branches immediately below the proximal bases of the polypites. The hydroid is light-brown.

It was found by Clarke, 1882, growing upon *Alcyonidium* at Hampton Roads, Virginia, and in the southern parts of Chesapeake Bay. A medusa believed to be of this species was found by me in Charleston Harbor, South Carolina, on December 17, 1904.

### Bougainvillia trinema.

*Margelis trinema*, VON LENDENFELD, 1884, Proc. Linnean Soc. New South Wales, vol. 9, p. 918, plate 41, fig. 13.

An immature medusa from Sydney Harbor, New South Wales, Australia. The bell is oval, rounded, 2 to 3 mm. wide. There are only 3 tentacles in each of the 4 clusters of marginal tentacles. These are about half as long as the bell-height. Each of the 4 oral tentacles ends in 3 (?) small, equal branches about one-third as long as the shaft of the oral tentacle. Entoderm of stomach and tentacle-bulbs dark yellow. This may possibly be the young of *B. fulva* Agassiz and Mayer, 1899, but von Lendenfeld's description and figure are too imperfect to determine this point.

### Bougainvillia frondosa Mayer.

Plate 16, fig. 6.

*Bougainvillia frondosa*, MAYER, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 41, fig. 5, plate 3.

The bell is higher than a hemisphere with relatively straight, vertical sides, and about 2 mm. high. There are 4 radially placed clusters of marginal tentacles, which are situated upon bulbs at the ends of the 4 radial-canals. Each bulb gives rise to but 2 tentacles, so that there are only 8 in all. There are no ocelli at the bases of the tentacles. The velum is narrow. There are 4 straight, narrow radial-canals and a simple, narrow ring-canal. The manubrium is cruciform in cross-section, short, thick, and flask-shaped. It extends about half the distance from the inner apex of the bell-cavity to the velar opening. There are 4 radially placed, oral tentacles, each of which branches dichotomously 2 or 3 times. Planulæ develop upon the sides of the stomach near, and on both sides of, the 4 principal radii. I at first considered these to be parasitic Zooxanthellæ, but further studies have shown that they are planulæ. Hartlaub, 1897, observes a similar phenomenon in *Bougainvillia superciliaris*, etc., and Maas, 1904, cites it in *Cytæis nigritina* (Résult. Camp. Prince de Monaco, fasc. 28, p. 8, plate 1, figs. 3, 4).

The entoderm of the manubrium and tentacle-bulbs is pinkish-white and the tentacle tips are turquoise. This medusa is occasionally found at Tortugas, Florida, in June to July.

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### Bougainvillia obscura Bonnevie.

*Bougainvillia obscura*, BONNEVIE, 1899, Bergens Mus. Aarbog for 1898, No. 5, p. 7, taf. 1, fig. 4, 4*a*.

The hydroid is small, about 20 mm. high. The hydrocaulus of the trophosome is about 3 mm. high, with almost opaque perisarc without foldings or rings. The polypites are about 2 mm. long, nearly cylindrical and with about 15 very long tentacles. The medusæ are set free, and are produced either singly or in small clusters upon branched processes immediately under the hydranths.

Found at Christiania. Color (?) Hydrorhiza (?) Description of medusæ (?) The species is said to differ from other Bougainvilliæ in its smooth, opaque perisarc, and in its long tentacles. It will be difficult to rediscover this form from its very meager description.

### Bougainvillia glorietta Torrey.

*Bougainvillia glorietta*, TORREY, 1904, Univ. California Publications, Zool., vol. 2, No. 1, p. 7, figs. 2, 3.

Stems branched, rising from a creeping hydrorhiza in clusters to the height of 20 to 30 mm. The stems and branches often twine about each other. Perisarc smooth, or wavy, covered with particles of detritus. Terminal polypites largest, with 20 to 25 tentacles in 2 or 3 irregular whorls, the outermost being the shortest. Tentacles highly contractile. Gonophores in groups of 2 or 3 on branches or hydranth stalks, mounted on short pedicels. The well-developed medusæ within the gonophores have 4 pairs of marginal, 4 simple, oral tentacles, and 8 ocelli. Color (?) Found at San Diego, California.

Distinguished by its smooth, unannulated perisarc and twining stems. Free medusa is unknown.

## Genus NEMOPSIS L. Agassiz, 1849.

*Nemopsis*, AGASSIZ, L., 1849, Mem. Amer. Acad., New Series, vol. 4, p. 289; 1862, Cont. Nat. Hist. U. S., vol. 4, p. 345.—McCRADY, 1857, Gymn. Charleston Harbor, p. 58.—AGASSIZ, A., 1862, Proc. Boston Soc. Nat. Hist., vol. 9, p. 98; 1865, North Amer. Acal., p. 149.—HAECKEL, 1879, Syst. der Medusen, p. 92.—BROOKS, 1883, Studies Biol. Lab. Johns Hopkins University, vol. 2, p. 468.—HARGITT, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 37.

This genus was founded by L. Agassiz, 1849, for *Nemopsis bachei* of the Atlantic coast of the United States south of Cape Cod.

### GENERIC CHARACTERS.

Margelinæ with 4 clusters of marginal tentacles, one at the extremity of each of the radial-canals. There are two sorts of tentacles in each cluster, a median pair of club-shaped tentacles with swollen extremities studded with nematocysts; and on both sides of this median pair there are a number of simple, filiform tentacles. The 4 radial lobes of the stomach extend outward along the radial-canals and the gonads are developed along the sides of these lobes. The hydroid is a *Bougainvillia*. In the *Nemopsis* hydroid, however, the medusæ arise from the sides of the naked polypites, not from the branches of the stems of the hydroid, as is usual in other species of *Bougainvillia*.

In common with *Bougainvillia* the medusa of *Nemopsis* has 4 dichotomously branching, oral tentacles. Its most striking feature is the wide extension of the 4 radial pouches of the stomach along the 4 radial-canals. This is, however, not of generic value, for it occurs to a greater or less degree in *Bougainvillia*. The sole distinctive generic feature of *Nemopsis* is the presence of two distinct sorts of tentacles upon each marginal bulb. L. Agassiz, in his first brief notice of this genus in 1849, called attention to its peculiar club-like median pair of tentacles and presents a good figure of them, but his description is not wholly correct, for the ocelli are not upon the ends of the tentacles, but are on the axial (inner) side of each tentacle adjacent to the pad-like base.

Haeckel, 1879, considers *Nemopsis* to be identical with *Favonia* of Péron and Lesueur, 1809; nevertheless he adopts the name *Nemopsis*, although maintaining the precedence of *Favonia*. I agree with Vanhöffen, 1891, and consider that *Favonia* is certainly not equivalent to *Nemopsis*. Blainville's (1834, Man. d'Actinologie) copy of Péron and Lesueur's figure of

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*Favonia* and his brief and unsatisfactory description are only confusing. It is evident that the figure is very erroneous, and it appears to bear a closer relationship to *Lymnorea* than to *Nemopsis*. No marginal tentacles are shown, and the flat, bell-shaped disk is wholly unlike any known species of *Nemopsis*.

*Favonia octonema* Péron et Lesueur is probably an imperfect specimen of some species of *Lymnorea*. Haeckel calls this "*Nemopsis favonia*."

I can distinguish no difference between Haeckel's *Nemopsis* "*heteronema*" and *N. bachei* of our coast. It was described from an isolated specimen found on the coast of Norway, and falls within the common limits of variability of *N. bachei* in all respects. It is possibly an individual which may have drifted across the Atlantic in the trend of the winds and currents.

The genus *Nemopsis* is evidently derived from the more generalized *Bougainvillia* in which the marginal tentacles have become specialized into two sorts and the 4 radial corners of the stomach have extended far outward along the radial-canals. The hydroid remains identical with that of *Bougainvillia*.

*Nemopsis* is one of those exceptional Anthomedusæ in which the gonads have migrated outward from the sides of the stomach along the radial-canals. *Dissonema* among the Tiarinæ is another instance of the same sort. In the medusæ we frequently find that the hard and fast distinctions which Haeckel attempts to apply to the separation of families do not hold in nature. Thus the gonads are often more or less interradial in the Codonidæ, or more or less upon the sides of the manubrium in the Thaumantiadæ; the lithocyst-bearing medusa *Eutima* arises from a hydroid having the superficial appearance of one of the Tubularian order, and *Rathkea fasciculata* is the only medusa of the Oceanidæ with 4 *perradial* gonads.

### Nemopsis bachei L. Agassiz.

Plate 17, figs. 5 and 6.

*Nemopsis bachei*, Agassiz, L., 1849, Mem. Amer. Acad., New Series, vol. 4, p. 289, 1 fig.—1862, Cont. Nat. Hist. U. S., vol. 4, p. 345.—Agassiz, A., 1862, Proc. Boston Soc. Nat. Hist., vol. 9, p. 98, figs. 26, 27.—1865, North Amer. Acal., p. 149, figs. 227-231.—Verrill, 1873, Report Commis. Fish and Fisheries U. S. for 1871-72, pp. 454, 733.—Haeckel, 1879, Syst. der Medusen, p. 93.—Brooks, 1883, Studies Johns Hopkins Univ. Biol. Lab., vol. 2, p. 468 (hydroid and young medusa).—Brooks, 1890, Handbook of Invert. Zool., p. 40, fig. 21.—Nutting, 1901, Bull. U. S. Fish Commission for 1899, vol. 19, p. 375, fig. 88.—Hargitt, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 41, 1 fig.; 1901, American Naturalist, vol. 35, p. 583, fig. 47; 1901, Biol. Bulletin, Woods Hole, vol. 2, p. 227.

*Nemopsis gibbesii*, McCrady, 1857, Gymn. Charleston Harbor, p. 58, plate 10, figs. 1–3, *non* figs. 4–7.

*Favonia bachei*, Haeckel, 1877, Prodrom. Syst. Medusen, No. 103 (unpublished).

*Nemopsis heteronema*, Haeckel, 1879, Syst. der Medusen, p. 93, taf. 5, fign. 6–9 (isolated specimen from coast of Norway).

*Adult medusa* (plate 17, fig. 6).—Bell about 11 mm. high, being higher than a hemisphere, with relatively straight sides and flat top. There are 4 radially situated clusters of marginal tentacles. Each cluster arises from a cleft, pad-like base and contains about 14 tentacles. The median pair of tentacles are short, slender, and terminate each in a knob-like cluster of nematocysts (plate 17, fig. 5). These median tentacles are flanked by a long, highly contractile pair which contain reddish-brown pigment in their ectoderm. On either side of these brown tentacles there are 5 transparent, highly contractile, filiform tentacles. When swimming the medusa often carries its tentacles with their shafts extending straight outward at an acute angle with the sides of the bell, while the extremity of each tentacle bends sharply downward at a right angle, recalling the appearance presented by the tentacles of *Gonionemus*. There is a dark-colored ectodermal ocellus at the base of each tentacle on the lower (velar) side. The bell-cavity is about three-quarters as deep as the bell-height. There are 4 straight, narrow radial-canals and a slender circular vessel. The velum is well developed. The gonads are flat and ribbon-like, with curtain-like folds, and they extend down the radial-canals, along the sides of the 4 stomach-pouches, which project about two-thirds the distance from the sides of the manubrium to the tentacle-bulbs. The manubrium is short, with 4 simple, quadratic lips, and with 4 radially situated clusters of oral tentacles. Each of these oral clusters arises from a single shaft which bifurcates from 5 to 7 times, terminating in 32 to 128 small, nematocyst-covered knobs. The entodermal cores of the oral tentacles consist of chordate cells. Gonads, stomach, and tentacle-bulbs dull milky-yellow to orange. This



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medusa is very abundant in autumn and winter along our Atlantic coast near the mouths of large bays into which pure ocean water has free access. It is not usually found in brackish water far from the ocean. It is found at Woods Hole, Massachusetts, and is common in Long Island Sound as far west as New Haven; in the mouth of the Chesapeake; in Pamlico Sound, especially near the inlets, and in the mouths of all southern harbors, in winter, as far south as Fernandina, Florida. It is also found off the coast in the ocean. It has not been seen north of Cape Cod, nor upon the southern Florida coast. Very often the medusa is seen with all of its marginal tentacles broken off short, leaving only rounded stumps, this condition being commonly found in animals living in brackish water or far from the ocean. *N. "heteronema"* Haeckel, 1879, appears to be identical with our American *N. bachei*.

*Hydroid and young medusa.*—McCrady, 1857, is mistaken in his identification of the hydroid of this medusa, for his hydroid is *Margelopsis*. The hydroid stock was found by Brooks, 1883, in Newport River, North Carolina, growing upon a piece of submerged wood. It is a *Bougainvillia*. The stems of the hydroid are about 25 mm. in height. Each main stem gives rise to 3 or 4 short alternating branches, and these as well as the main stem end in hydranths, which are sharply separated from the stem by means of a fold or collar. The stems are covered by a thin, transparent, horny ectosarc which extends almost, but not quite, up to the basal collar of the polypites. There are 2 or 3 irregular annulations upon the ectosarc of the side branches, close to the main stem. Each polypite bears 24 long, slender tentacles, which arise in a single circlet near the distal end of the hydranths. The mouth is situated at the extremity of a well-developed proboscis which is funnel-shaped and sharply distinguished from the body of the hydranth. 6 or 8 medusa-buds, in various stages of development, are arranged in a circlet situated upon some of the hydranths between the distal base and the circlet of tentacles. The terminal hydranths and those near the free end of the main stem bear no medusæ, for these appear to be developed upon the old hydranths. The hydroid of *Nemopsis* is thus a *Bougainvillia*, but the medusæ arise from the sides of the polypites, not from the stems.

When set free the medusa is flattened and folded so that the manubrium projects beyond the velar opening. In about an hour, however, it expands and begins to swim. It is then about 0.5 mm. in height, and the bell is globular, being about as broad as high. The manubrium is short and tubular and without oral tentacles. In some individuals there are 8 tentacles, 2 at the base of each radial tube. In others there are but 4 primary tentacles, one upon each tentacle-bulb at the base of the 4 radial tubes.

As development proceeds the marginal tentacles increase in number, those which are nearest the middle of the basal bulbs being the oldest. The new tentacles appear at the sides near the base of the cone-shaped basal bulb. The 4 oral tentacles develop upon the 4 radial sides of the manubrium, and finally the gonads begin to develop upon the 4 radial-canals adjacent to the sides of the manubrium and finally extend down almost the entire length of the radial-canals.

According to Hargitt, 1901, about 5 per cent of the medusæ of *N. bachei* display variations of a numerical nature in the radial-canals, manubrium, gonads, and tentacles.

### Nemopsis crucifera Haeckel.

*Hippocrene crucifera*, FORBES, 1853, Trans. Roy. Soc. Edinburgh, vol. 20, p. 313, plate 10, fig. 5.
*Nemopsis crucifera*, HAECKEL, 1880, Syst. der Medusen, p. 635.

This species is distinguished from *N. bachei* by its dark-red color and possibly by its more nearly spherical bell.

Bell oval, 4 mm. wide, 4 mm. high. Each of the 4 marginal tentacle-bulbs bears a median pair of short, stiff, club-shaped tentacles, flanked on either side by 2 to 3 longer filiform tentacles. There are thus 6 to 8 tentacles upon each marginal bulb. The stomach is cruciform, and its sides extend half-way down the 4 radial-canals. The oral tentacles are short and branch twice dichotomously. The gonads are as in *N. bachei*. Forbes shows the stomach, gonads, and tentacle-bulbs of a darker red color than has been observed in *N. bachei*. The tentacular ocelli are black. Found by Forbes and Haeckel at Tobermory and Handa Island, off the west coast of Scotland.

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## Genus RATHKEA Brandt, 1837, sensu Vanhöffen.

*Rathkea*, Brandt, 1837, Bull. Sci. Acad. St. Pétersbourg, vol. 1, p. 187; 1838, Mém. Acad. Imp. St. Pétersbourg, sér. 6, tome 4, p. 353.
*Cytæis*, in part, Sars, 1835, Beskriv. og Jagttag, p. 28.
*Lizzia*, Forbes, 1846, Annals and Mag. Nat. Hist., ser. 1, vol. 18, p. 286; 1848, British Naked-eyed Medusæ, p. 64. Claparède, 1860, Zeit. für wissen. Zool., Bd. 10, p. 401, taf. 32, fign. 1–3.—Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 345.—Agassiz, A., 1865, North Amer. Acal., p. 161.—Wagner, 1885, Wirbellosen des Weissen Meeres, p. 73.—Garstang, 1904, Journ. Marine Biol. Association, Plymouth, New Series, vol. 3, p. 213. Maas, 1897, Mem. Mus. Comp. Zool. at Harvard College, vol. 23, p. 14.—Hargitt, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 37.
*Rathkea + Margellium + Lizzia*, Chun, 1895, Bibliotheca Zoologica, Heft 19, Lfg. 1, pp. 13, 16, 24, 36, etc.
*Margellium*, Browne, 1895, Proc. and Trans. Liverpool Biol. Soc., vol. 9, p. 270; 1896, Proc. Zool. Soc. London. *Margellium*, p. 477; *Lizzia*, p. 475.
*Lizzia + Lizzella + Margellium + Rathkea*, Haeckel, 1879, Syst. der Medusen, pp. 72, 82, 83, 94, 96.
*Rathkea*, Lütken, 1850, Vidensk. Meddel. Nat. Foren. Kjobenhavn, pp. 18, 25. –Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 345.—Metschnikoff, 1886, Embryol. Studien an Medusen, pp. 23, 37, 48, etc. –Vanhoffen, 1891, Zool. Anzeiger, Jahrg. 14, p. 445.
*Lizzia + Rathkea*, Maas, 1897, Mem. Museum Comp. Zool. at Harvard College, vol. 23, p. 14; 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 12.—Bedot, 1905, Revue Suisse de Zool., tome 13, pp. 137, 144 (citation of references to 1850).

The type species is *Rathkea blumenbachii* Brandt, of the Black Sea. I believe future studies will show that this medusa is identical with *Rathkea octopunctata*.

In 1846-48 Forbes introduced the generic name "*Lizzia*," applying it to *Lizzia octopunctata*, which Browne and Garstang have shown to be identical with *Cytæis octopunctata* of Sars, 1835.

Haeckel, 1879, defines the following genera:

| | Haeckel's name. | | | |
|---|---|---|---|---|
| | Lizzia. | Margellium. | Lizzella. | Rathkea. |
| Condition of oral tentacles. | Unbranched. | Branched. | Unbranched. | Branched. |
| Condition of the 8 clusters of marginal tentacles. | 4 radial clusters have more tentacles than the 4 interradial. | 4 radial clusters have more tentacles than the 4 interradial. | All 8 tentacular clusters alike. | All 8 tentacular clusters alike. |

Vanhöffen, 1891, shows that "*Lizzia*, *Margellium*, and *Lizzella*" are stages in the growth of *Rathkea*.

Much confusion has thus been introduced by the too narrow definition of genera, as restricted by Haeckel, and it seems well to broaden the genus so as to make it apply to these medusæ in all stages of their free life.

### GENERIC CHARACTERS.

Margelinæ with simple or branched oral tentacles and 8 clusters of marginal tentacles, 4 radial and 4 interradial.

There are perradial, adradial, or interradial gonads on the sides of the stomach and the oral tentacles terminate in knob-like clusters of nematocysts.

In *Rathkea* medusa-buds are commonly developed upon the sides of the manubrium. Chun, 1895, has shown that these buds are produced entirely from the ectoderm of the parent medusa. A short time before the young medusa is set free, however, a connection is established between the gastrovascular cavity of the bud and that of the mother medusa. Claparède, 1860, describes a "*Lizzia*" from Scotland in which the embryos are developed upon the outer walls of the stomach very much as is the case with the planulæ of *Bougainvillia superciliaris*. In the case of this "*Lizzia*," however, the eggs, or embryos, are set free inclosed in capsules and then develop directly into medusæ. This remarkable observation awaits confirmation.

According to Browne, 1896 (Proc. Zool. Soc. London, p. 477), the medusa of *Lizzia* (*Rathkea*) *octopunctata* first reproduces itself by means of medusa-buds upon the manubrium, and when it reaches the adult condition either ova or spermatozoa develop within the ectodermal wall of the stomach, the sexes being separate; and the same statement applies to *Rathkea blondina*.

It is highly probable that the very variable *R. octopunctata* is found in the Mediterranean and along the Atlantic coasts of Europe and America, and that *R. blumenbachii* and *R. blondina* are only synonyms. *R. fasciculata* is the only known Anthomedusa in which the gonads are restricted to the *perradial* sides of the manubrium.

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*Tabular Synopsis of the Species of Rathkea.*

| | Rathkea blumenbachii Brandt, 1837 to 1838. | R. formosissima = Lizzia formosissima Browne. | R. octopunctata = Cytæis octopunctata Sars, 1835 to 1846 = Lizzia octopunctata Forbes, 1848. | R. octopunctata var. grata = Lizzia grata A. Agassiz, 1862 to 1865. | R. fasciculata = Melicerta fasciculata Péron et Lesueur. Lizzia köllikeri Gegenbaur, 1854 to 1856. | R. octonemalis Maas, 1905. | R. elegans = Lizzia elegans Mayer, 1900. | R. blondina = Lizzia blondina Forbes. |
|---|---|---|---|---|---|---|---|---|
| Shape and size of bell in mm. | Bell-shaped. 6 high, 4 wide. | Bell-shaped. 3 high, 2.5 wide. | Pyriform. 5 high, 4.5 wide. | Pyriform. 3 to 5 high, 3 wide. | Globular. Widest at upper two-thirds of bell. 15 high, 12 wide. | Globular, dome-like. 6 high, 5 wide. | Apex dome-like, sides vertical. 6 high, 5 wide. | Pyriform. 6 high, 4 wide. |
| No. of tentacles in each of the 8 marginal clusters. | 3 in each cluster (24 in all). | 5 in each radial, 3 in each interradial cluster. | 4 to 5 in each radial cluster. 3 in each interradial cluster. When half-grown there are 3 tentacles in each of the 8 clusters. | 5 in radial, 3 in interradial clusters. As in R. octopunctata. | 15 to 20 in each of the 8 clusters when mature. When only 3 mm. high there are 7 in radial and 5 in interradial clusters. | 7 to 9 in radial, 5 to 7 in interradial clusters. | 4 in radial, 3 in interradial clusters. | 3 in each radial cluster. 4 small isolated interradial tentacles. |
| Condition of oral tentacles. | 4 oral tentacles, each with 3 pairs of simple lateral branches. | 4 oral tentacles, each with a simple terminal cluster and 3 to 5 pairs of nematocysts. | 4 forked oral tentacles, each with pair of nematocyst-knobs at its base. | As in R. octopunctata. | Each of 4 oral tentacles, branches dichotomously 6 to 8 times. | Each of 4 oral tentacles branches dichotomously 4 to 5 times. | Branched, dichotomously 3 to 4 times. | 4 simple, unbranched. |
| Form and size of manubrium. | A short, conical peduncle about half as long as stomach. Both together half to two-thirds as long as depth of bell-cavity. | Peduncle about as long as stomach. | Peduncle about as long as stomach. Both together about half as long as depth of bell-cavity. | Peduncle 1.5 times as long as stomach. Both together about two-thirds as long as depth of bell-cavity. | Peduncle not quite as long as stomach. | Peduncle about as long as stomach. Both together about half as long as depth of bell-cavity. | As in R. octonemalis. | As in R. octopunctata. |
| Gonads. | 8 (?) interradial. No medusa-buds observed. | 4 interradial. When young, medusæ produce medusa-buds. | When young, medusa-buds developed in the 4 interradii of stomach. When older, this budding ceases and sexual products develop. | As in R. octopunctata. | 4 perradial gonads, each gonad forming a crescent around place of entrance of radial-canal into manubrium. | 4 interradial horse-shoe-shaped. No medusa-buds. | Interradial. No medusa-buds. | As in R. octopunctata. |
| Color | Tentacle-bulbs brownish-yellow. Stomach straw-colored. Gonads and tentacles milky-white. | ? | Entoderm of stomach and tentacle-bulbs ranges from brownish-green to black. | Entoderm of stomach and tentacle-bulbs ranges from brownish-green to orange. | Entoderm of stomach and tentacle-bulbs red to brownish-red. | Brownish-red as in R. fasciculata. | Stomach bright-green, tentacles and canal system pearly-pink. | Stomach and tentacle-bulbs amber to yellow. |
| Where found. | Black Sea, Russia. Sebastopol, April. | Falkland Islands, Atlantic coast of South America. | Arctic Ocean and North Atlantic coasts of Europe and America. | Atlantic coast of North America, north of New Jersey. | Mediterranean. | Malay Archipelago. | Tortugas, Florida. | Coasts of Great Britain, France, and Germany. |
| Distinctive characters. | Distinguished by pinnate, oral tentacles and short peduncle. These may be erroneously described by Rathke, and medusa is probably identical with R. octopunctata. | Pinnate, oral tentacles, and large number of marginal tentacles. Is this identical with R. octopunctata? | Oral tentacles forked, and provided with lateral nematocyst-knob; thus combining characters of pinnate and dichotomous tentacles. | An American, local variety of O. octopunctata. | Dichotomous, oral tentacles. Large number of marginal tentacles. | Very small basal stalks of dichotomously branched oral tentacles. Small number of marginal tentacles. | Brilliant green coloration. Dichotomous oral tentacles. | Simple, unbranched oral tentacles. |

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According to Gegenbaur, 1854 (Generationswechsel Polypen und Medusen, pp. 22-28, Taf. 2, fign. 1 9), the egg of *Rathkea fasciculata* develops into a solitary polyp covered with a horny peritheca and provided with 4 tentacles. The segmentation stages were studied by Metschnikoff, 1886.

The oral tentacles in the young medusæ are unbranched, but in the majority of the species they become forked as growth proceeds. In *Rathkea blondina* (*Lizzia blondina* Forbes) they remain simple and unbranched throughout life. It appears best, however, not to separate *Lizzia* from the older genus *Rathkea* on the ground that *Lizzia* has simple tentacles throughout its life, for all of these medusæ have simple oral tentacles when young and their forked character in later life may better be considered specific rather than generic.

**Rathkea blumenbachii Brandt.**

*Oceania blumenbachii*, RATHKE, 1835, Mém. Acad. Imp. Sci. St. Pétersbourg, tome 2, p. 321, taf. 1, fign. 1-4.
(*?*) *Cytæis octopunctata*, SARS, 1835, Beskriv og Jagttag, p. 28, plate 6, figs. 14*a*-14*g*.
*Rathkia blumenbachiana*, BRANDT, 1837, Bull. Sci. Acad. St. Pétersbourg, vol. 1, No. 24, p. 187. Also: *R. oceania blumenbachii*, 1838, Mém. Acad. Imp. Sci. St. Pétersbourg, sér. 6, tome 4, p. 353.
*Rathkea blumenbachii*, HAECKEL, 1879, Syst. der Medusen, p. 96.
*Rathkea blumenbachi*, BIDOT, 1905, Revue Suisse de Zool., tome 13, p. 144 (literature 1835-50).

This medusa has a pyriform bell with thick, gelatinous walls. Bell-cavity about two-thirds as deep as the bell-height. 8 marginal clusters, each with 3 tentacles all of equal length and as long as the bell-height. 4 radial-canals. Stomach mounted on a short, conical peduncle. Stomach and peduncle together are about one-half to two-thirds as long as the depth of the bell-cavity. 4 radially placed, oral tentacles, each of which forks at its end and gives rise also to 4 short, side branches, 2 on each side of the tentacles. 8 gonads (?) No medusa-buds. Stomach and tentacle-bulbs brownish-yellow. Sebastopol, Russia, in April.

For further description, see synoptic table of species of *Rathkea*.

Rathke's drawing is inaccurate in showing 8 radial-canals. The 4 interradial radiating muscle strands were doubtless mistaken for radial-canals. I am inclined to suspect that this medusa may be identical with the better-known *Rathkea octopunctata*.

**Rathkea formosissima.**

*Lizzia formosissima*, BROWNE, 1902, Annals and Mag. Nat. Hist., ser. 7, vol. 9, p. 278.

Umbrella bell-shaped, 3 mm. high and 2.5 mm. broad, with a slight, transverse constriction level with the top of the subumbrella cavity and a solid mass of jelly above it. 5 tentacles in each radial, and 3 in each interradial, cluster. Stomach small, somewhat cubical, about as long as broad, and situated on a broad peduncle about as long as the stomach. Mouth with a plain, simple margin, somewhat quadrangular in shape. There are 4 oral tentacles, each with 7 to 11 clusters of nematocysts consisting in a terminal cluster and 6 to 10 lateral clusters in a double row. Gonads on the stomach in 4 interradial, roundish swellings or masses. The young medusæ have medusa-buds upon the stomach and only 3 tentacles in each group. Color (?) Found at Stanley Harbor, Falkland Islands, South Atlantic coast of South America.

**Rathkea octopunctata Haeckel.**

Plate 20, fig. 11.

(?) *Oceania blumenbachii*, RATHKE, 1835, Mém. Acad. Imp. Sci. St. Pétersbourg, tome 2, p. 321, 4 figs.
*Cytæis* (?) *octopunctata*, SARS, 1835, Beskriv og Jagttag, p. 28, plate 6, figs. 14*a*-14*g*.
*Cytæis octopunctata*, SARS, 1846, Fauna Littor. Norveg., tome 1, p. 10, plate 4, figs. 7-13.- LINKO, 1900, Travaux Soc. Imp. des Nat. de St. Pétersbourg, tome 29, p. 152, fig. 2.
*Hippocrene octopunctata*, FORBES, 1841, Ann. and Mag. Nat. Hist., vol. 7, p. 84.
*Bougainvillia octopunctata*, LESSON, 1843, Hist. Zooph. Acal., p. 292.
*Lizzia octopunctata*, FORBES, 1848, British Naked-eyed Medusæ, p. 64, plate 12, figs. 3*a* to 3*e*. AGASSIZ, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 345.—VAN BENEDEN, 1867, Mém. de l'Acad. Belgique, tome 36, p. 94, plate 3, figs. 7-13 (*Circe hyalina*, p. 95, plate 3, fig. 14).—BOHM, 1878, Jenaische Zeit. fur Naturw., Bd. 12, p. 186, taf. 4-6, fign. 1-4. FEWKES, 1884, Mem. Mus. Comp. Zool. at Harvard College, vol. 9, No. 3, plate 5, figs. 20-22.- M'INTOSH, 1890, Ann. and Mag. Nat. Hist., ser. 6, vol. 5. p. 298.
*Margellium octopunctatum* + *Rathkea octopunctata*, HAECKEL, 1879, Syst. der Medusen, pp. 95, 97.
*Lizzia grata*, FEWKES, 1881, Bull. Mus. Comp. Zool. at Harvard College, vol. 8, p. 142, plate 1, figs. 1-7.
*Rathkea octopunctata*, CHUN, 1895, Bibliotheca Zoologica, Atlantis, Heft 19, Lfg. 1, pp. 15, 17, 24, taf. 2, fign. 1-13.
*Margellium octopunctatum*, BROWNE, 1896, Proc. Zool. Soc. London, p. 477; 1895, Proc. and Trans. Liverpool Biol. Soc., vol. 9, p. 270.—LINKO, 1904, Zool. Anzeiger, Bd. 28, p. 216.

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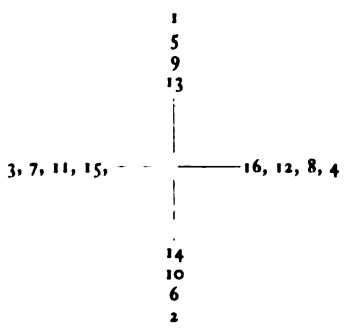
*Rathkea octopunctata*, GIARD, 1888, Bull. Sci. France Belg., sér. 3, année 1, p. 317, plate 21.—CHUN, 1896, Bronn's Thier-Reichs, Bd. 2, Abth. 2, p. 253, taf. 12 (development of medusa-buds).—BEDOT, 1905, Revue Suisse de Zool., tome 13, p. 145 (all papers cited to 1850).

*Margellium octopunctatum*, BROWNE, 1903, Bergens Museums Aarbog, No. 4, p. 15; 1905, Proc. Royal. Soc. Edinburgh, vol. 25, p. 755.

*Cubogaster gemmascens*, HAECKEL, 1879, Syst. der Medusen, p. 76, taf. 6, figs. 8–11 (young budding medusa with only 2 marginal tentacles).

*Adult medusa*.—Bell pyriform, with solid, apical projection, and about 5 mm. in height and 4.5 mm. in diameter. Gelatinous substance thick at the apex of the bell, but thin upon sides of bell-cavity. There are 8 clusters of marginal tentacles. 4 of these are radial and are situated at the bases of the 4 radial-canals, and the 4 others are interradial and are situated 45° from the radial clusters. In the fully-grown medusa there are usually about 4 or 5 tentacles in each radial cluster, while the interradial clusters are each composed of not more than 3 tentacles. When the medusa is not yet fully grown, however, there are normally 3 tentacles in both radial and interradial clusters. Tentacle-bulbs large and swollen and filled with entodermal pigment-granules. Velum well developed. There are 4 straight, narrow radial-canals. The manubrium is provided with a distinct peduncle which, however, does not extend more than one-third of the distance from the inner apex of the bell-cavity to the velar opening. The gastric portion of the manubrium is short and quadratic in cross-section. The mouth is surrounded by 4 prominent lips. Each lip terminates in a pair of oral tentacles each of which ends in a knob-shaped cluster of nematocysts. In addition to these there is also a pair of knob-shaped clusters of nematocysts upon the sides of each lip, centripetal to the terminal knobs. Medusa-buds are developed upon the sides of the manubrium about the region of the stomach. These medusa-buds appear on interradially situated positions on the stomach-wall. According to Chun (1895, Bibliotheca Zool., pp. 20, 21) the order of development of the medusa-buds follows a very definite law. The oldest buds appear nearest the peduncle of the manubrium and the youngest are found lower down nearer the oral tentacles. The accompanying diagram will serve to illustrate the law of succession in position and in time of the various buds upon the manubrium (1) being the oldest bud and (16) the youngest (newest).




The oldest buds are developed near the proximal base of the stomach, and the newest and youngest are found near the bases of the oral tentacles. Even before they are set free the young medusæ begin to develop buds on their stomach-walls, and these secondary medusa-buds follow the same laws of time and place of development as do the primary medusa-buds (see Chun, 1895, p. 23). Chun, 1895, showed that the medusa-buds were formed entirely from the *ectoderm* of the manubrium, the entoderm taking no part in their development. As the bud becomes older, however, a connection is formed between its gastrovascular cavity and that of the mother medusa. The developing medusa-bud has, at first, only 4 radial tentacles, one at the base of each radial-canal. When set free, however, it possesses 16 tentacles: 4 clusters each of the 3 tentacles at the bases of the 4 radial-canals; and also 4 simple interradial tentacles. The color of the entoderm of the manubrium and tentacle-bulbs varies from brown-green to black.

This medusa is common in the north Atlantic, where it has been taken off the coasts of Norway, Barents Sea, Helgoland, England, Ireland, Scotland, and New England. Fewkes found it in Narragansett Bay, Rhode Island, and it is common on the southern coast of New England in March. Browne records this species from Valencia Harbor, coast of Ireland. Levinsen, 1893, found it off the west coast of Greenland. I believe that future studies will show that *R. blumenbachii* of the Black Sea is identical with *R. octopunctata*. The drawing of the oral tentacles of *R. blumenbachii* in Rathke's memoir is evidently diagrammatic and probably quite erroneous. *R. blumenbachii* appears to be merely an *R. octopunctata* in an intermediate stage of growth wherein it has 3 tentacles in each of its 8 marginal clusters.

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### Rathkea octopunctata var. grata A. Agassiz.

Plate 18, fig. 5.

*Lizzia grata*, Agassiz, A., 1862, Proc. Boston Soc. Nat. Hist., vol. 9, p. 100, figs. 28, 29; 1865, North Amer. Acal., p. 161, figs. 251–258.—Nutting, 1901, Bull. U. S. Fish Commission, vol. 19, p. 376, fig. 91. Hargitt, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 39, plate 1, fig. 4.
*Neo Lizzia grata*, Fewkes, 1881, Bull. Mus. Comp. Zool. at Harvard College, vol. 8, No. 8, p. 142, plate 1, figs. 1–7.
*Margellium gratum*, Haeckel, 1879, Syst. der Medusen, p. 95. Levinsen, 1893, Vid. Meddel. Nat. For. Kjobenhavn (5), Bd. 4, p. 145.

*Adult medusa* (plate 18, fig. 5).—Bell about 3.5 mm. in height and 3 mm. in diameter; pyriform in shape, and with well-developed apical projection which is solid. The gelatinous substance is thick at the apex of the bell, but thin upon the sides. There are 8 clusters of marginal tentacles, 4 radial and 4 interradial. The radial clusters are each composed of 5 tentacles, while the interradial clusters contain only 3 tentacles each. The tentacles are long and flexible and are usually carried curled upward. The basal bulbs are large and filled with entodermal pigment-granules. The velum is well developed. There are 4 slender, straight radial-canals. The peduncle of the manubrium is long and extends about two-thirds of the distance from the apex of the bell-cavity to the velar opening. The gastric portion of the manubrium is small, and quadratic in cross-section. There are 4 prominent lips, each of which terminates in a pair of oral tentacles which end in knob-shaped clusters of nematocyst-cells. There is also found a pair of knob-shaped nematocystic clusters upon the sides of each lip. Medusa-buds are developed in the interradii upon the sides of the manubrium. The entoderm of the tentacle-bulbs and manubrium is usually intense orange, but in some cases the stomach is sage-green and the tentacle-bulbs russet.

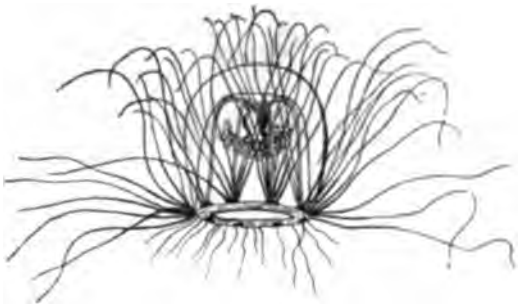

Fig. 93.—*Rathkea "kollikeri,"* = *R. fasciculata*, after Gegenbaur, in Zeit. für wissen. Zool., Bd. 8.

*Young medusa.*—In a medusa 1.2 mm. in height there are 16 tentacles: 4 radial clusters each consisting of 3 tentacles and 4 simple, interradial tentacles. The peduncle is long and has the shape of the frustum of a cone. The stomach is short and there are 4 simple lips which terminate each in a single knob-shaped cluster of nematocyst-cells. No medusa-buds are yet to be seen upon the manubrium.

The medusa-buds upon the manubrium of the adult have at first only 4 simple tentacles, one at the foot of each radial-canal. At this stage there are also 4 small interradial tentacle-bulbs, which lack tentacles. It is not known what condition the medusa-buds may be in at the time of their liberation from the parent.

This variety is probably an Arctic form. It appears in Newport Harbor, Rhode Island, and in Massachusetts Bay during February, and disappears before June.

It is distinguished from the European and American *L. octopunctata* by its color and the great length of the peduncle of the manubrium. Also the medusa-buds do not seem to make their appearance until some time after the liberation of the young medusa, while in *Lizzia octopunctata* they develop upon the stomach of the young medusa while it is yet attached to its mother.

### Rathkea fasciculata Haeckel.

*Mitrocerta fasciculata*, Péron et Lesueur, 1809, Annal. du Mus. Hist. Nat., tome 14, p. 353, Paris.
*Kollikeria fasciculata*, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 345.
*Rathkea fasciculata*, Haeckel, 1879, Syst. der Medusen, p. 97. –Metschnikoff, E., 1886, Arbeit. Zool. Inst. Wien, Bd. 6, p. 239. Metschnikoff, 1886, Embryol. Studien an Medusen, Wien, pp. 23 (egg), 37 (segmentation), 48 (formation of entoderm), taf. 1, figs. 18–31. Maas, 1897, Mem. Mus. Comp. Zool. at Harvard College, vol. 23, p. 16; 1904, Result Camp. Sci. Prince de Monaco, fasc. 28, p. 10. –Bedot, 1901, Revue Suisse de Zool., tome 9, p. 486; *Ibid.*, 1905, tome 13, p. 145 (all literature to 1850).
*Lizzia kollikeri*, Gegenbaur, 1856, Zeit. fur wissen. Zool., Bd. 8, p. 225, taf. 7, figs. 5–9. Keferstein und Ehlers, 1861, Zoolog. Beitrag, p. 84, taf. 13, fig. 10.
*Bougainvillia kollikeri*, Leuckart, 1856, Archiv. fur Naturgesch., Bd. 22, p. 24, taf. 2, fig. 2.

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This large Mediterranean form is described in the synoptic table of species of *Rathkea*. Gegenbaur, 1854 (Generationswechsel und Fortplanz. bei Medusen, etc., p. 22, taf. 2, fign. 1–9), raised the larva until it developed into a solitary hydroid, 0.5 mm. long, with 4 tentacles, each beset with a row of nematocysts. A horny perisarc covered the hydrorhiza.

The stages of segmentation were studied by Metschnikoff, 1886. The egg is 0.11 mm. wide and yellowish to white in color. The segmentation is total and equal, and results in the formation of an elongated, ciliated, one-layered blastula with a large, central, segmentation cavity. The ectoderm is formed by the cells which wander into the segmentation cavity by ingression from the hinder end of the larva.

The medusa is quite common at Naples, Italy, during the winter. The bell is barrel-shaped with a flatly-rounded apex. It is 8 mm. high and 9 mm. wide. The marginal tentacles are highly contractile. There are 10 to 13 tentacles in each of the 8 clusters. Each

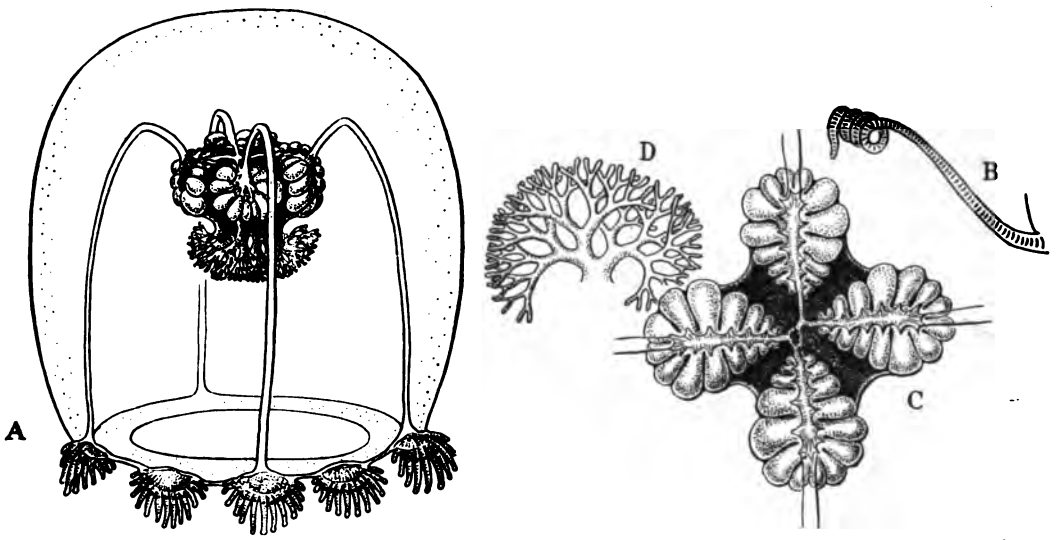


FIG. 94.—*Rathkea fasciculata*. From living and preserved specimens, by the author. Zoological Station, Naples, Italy. *A*, Side view of medusa with tentacles strongly contracted. *B*, Tentacle showing ocellus. *C*, Aboral view of manubrium. *D*, View of oral tentacle, contracted.

tentacle bears an ocellus on its inner side. The oral tentacles branch dichotomously 7 times. Whenever the medusa is disturbed by a mechanical shock the oral tentacles suddenly *expand* to their full extent, forming a network of filaments around the mouth, and thus it is seen that through this fortuitous reaction the medusa captures its prey. Such a reaction is remarkable, for in common with other medusæ all other parts of the animal *contract* when disturbed.

The 4 gonads form horseshoe-shaped, swollen crescents with transverse furrows. Each crescent surrounds the point of entrance of the radial-canal into the stomach and the horns of the crescent are directed aborally. There are thus 4 *perradial* gonads. This being the only instance of perradial gonods seen in the anthomedusæ.

### Rathkea octonemalis Maas.

*Rathkea octonemalis*, MAAS, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 12, taf. 2, fign. 11, 12.
(??) *Lizzella octella*, HAECKEL, 1879, Syst. der Medusen, p. 84.

Bell 5 to 6 mm. high, 4 to 5 mm. wide, with thick, gelatinous walls, bulging sides, and flat top. There are 8 clusters of marginal tentacles. 7 to 9 tentacles in each of the 4 radial, and 5 to 7 tentacles in each of the 4 interradial clusters. These tentacles are not one-fourth as long as the bell-height, and there is a black ectodermal ocellus upon the inner side of each tentacle near the point of origin of the tentacle from the basal bulb.

The 4 radial-canals and the ring-canal are straight, narrow, and simple. The stomach is mounted upon a short, wide, conical peduncle. The mouth is surrounded by 4 clusters of oral tentacles. Each cluster arises from a short basal stalk and branches dichotomously 4 to 5 times. The basal stalks of these clusters are so short and the forked branches so long that the mouth appears at first sight to be surrounded by 8 clusters of tentacles. This impression is, however, erroneous, for there are but 4 clusters of oral tentacles. The mouth does not

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extend to the level of the velar opening. The gonads are on the 4 interradial sides of the stomach. They are doubly cleft in each interradius so as to present the appearance of 4 longitudinal bands below, but are fused above, forming a double horseshoe. The tentacle-bulbs have decided red, entodermal pigment. The stomach is reddish-brown and the eggs appear as flecks of yellow.

Found in the Malay Archipelago, Ternate, 3° 46′ S. lat., 127° 47′ long. E. from Greenwich.

It is possible that *Lizzella octella* Haeckel may be identical with this species. Haeckel gives a very brief description of this medusa as follows: Bell egg-shaped, 15 mm. high, 10 mm. wide. Stomach globular or almost cubical, about as long as its conical peduncle. Gonads 4-feathered leaves in the stomach-wall. 8 simple, unbranched, oral tentacles as long as the stomach. (Broken?) 8 marginal tentacle clusters, each with 8 long tentacles. Coast of Japan. Color (?)

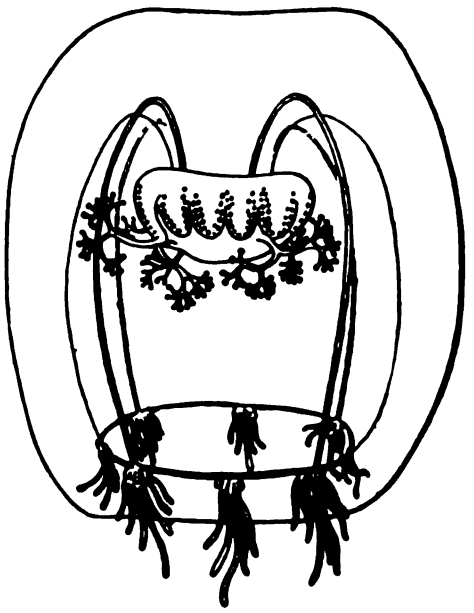

FIG. 95.—*Rathkea octonemalis*, after Maas, in Hydromedusen *Siboga* Expedition.

**Rathkea elegans.**

Plate 18, fig. 4.

*Lizzia elegans*, MAYER, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 44, plate 38, fig. 127.

Bell 3 to 7 mm. in height and gelatinous substance of moderate and nearly uniform thickness. The sides of the bell are almost straight and vertical and the top is dome-shaped. There are 8 groups of marginal tentacles, 4 radial and 4 interradial. Each radial group is composed of 4, and each interradial of 3 tentacles. The tentacles are quite stiff and curve upward and are only about half as long as the bell-height. There is a small, dark-brown, ectodermal ocellus upon the under (velar) side of each tentacle near the basal bulb. The velum is wide and provided with strong muscles. There are 4 straight, narrow radial-canals and a simple circular vessel. There is a well-developed, conical peduncle above the stomach, down which the radial-canals lead in their course to the gastric sac. The gastric part of the manubrium is cruciform in cross-section and pear-shaped in general longitudinal contour. The mouth is a simple opening without prominent lips. The oral tentacles arise from 4 radial sides of the stomach at a short distance above the mouth. Each tentacle branches dichotomously 3 times, and then each tip terminates in 3 small branches which are covered with nematocysts. The entodermal cells of the oral tentacles are chordate. The genital products are situated upon the four interradial sides of the stomach.

The entoderm of the tentacle-bulbs and radial-canals is of an intense, opaque, pearly-white color, often displaying a tinge of pink. The entoderm of the stomach is of an intense green, and the oral tentacles are pearly-pink. The intense opaque color of the radial-canals contrasting with the hyaline transparency of the bell renders this medusa one of the most beautiful found at the Tortugas, Florida. Several specimens were captured early in July, 1899.

**Rathkea blondina.**

*Lizzia blondina*, FORBES, 1848, British Naked-eyed Medusæ, p. 67, plate 12, fig. 4. BIDOT, 1905, Revue Suisse Zool., Bd. 13, p. 137 (literature 1848-50).—BROWNE, 1895, Trans. Liverpool Biol. Soc., vol. 9, p. 265; 1896, Proc. Zool. Soc. of London for 1896, p. 475 (review of recent literature, etc.); 1898, Journal Marine Biol. Assoc., N. S., vol. 5, p. 188. —(FORBES), BROWNE, 1896, Proc. Zool. Soc. London, p. 475

*Lizzia*, sp., CLAPARÈDE, 1860, Zeit. fur wissen. Zool., Bd. 10, p. 401, taf. 32, fign. 1-3.

*Dysmorphosa minima* (young stage) + *Lizzia claparedei* + *L. blondina*, HAECKEL, 1879, Syst. der Medusen, pp. 78, 82, taf. 6, fig. 7.

*Lizzia claparedei*, CHUN, 1895, Bibliotheca Zoologica, Heft 19, p. 36 (budding of medusæ), figs. 2-4. HAECKEL = *Lizzia blondina*, FORBES, BROWNE, 1905, Proc. Roy. Soc. Edinburgh, vol. 25, p. 754.

(?) *Lizzia elizabethæ*, HAECKEL, 1879, Syst. der Medusen, p. 83, taf. 6, fig. 12.

*Dysmorphosa minima* (young medusa), BROWNE, 1895, Trans. Liverpool Biol. Soc., vol. 9, p. 260.

*Dysmorphosa minima*, HAECKEL = *Lizzia claparedei*, HARTLAUB, 1897, Wissen. Meeresuntersuch. Deutsch. Meere, Neue Folge, Abth. Helgoland, Bd. 2, p. 455. —HAECKEL = *Lizzia claparedei*, BROCH, 1905, Bergens Museum Aarbog, vol. 11, p. 5.

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*Mature medusa.*—Bell 6 mm. high, 4 mm. wide. Pyriform. There are 3 tentacles in each of the 4 radial, marginal clusters and only one tentacle in each interradius. The stomach is mounted upon a short peduncle, and both together are hardly half as long as the depth of the bell-cavity. There are 4 radially placed, simple, unbranched, oral tentacles, each of which terminates in a knob-like cluster of nematocysts and is as long as the stomach itself. When immature the medusa produces medusa-buds upon the interradial sides of the stomach, but later, when there are 3 tentacles in each radial cluster, the budding ceases and ova or sperm develop. Claparède discovered that the eggs are inclosed in nematocyst-bearing capsules, reminding one of the condition observed in *Bougainvillia superciliaris*. Browne states that the medusa may become sexually mature when the bell is only 1.5 mm. high. The stomach, gonads, and tentacle-bulbs are amber-yellow. Found off the coasts of England, Ireland, Scotland, Germany, and Norway.

When the medusa is young there are only 8 marginal tentacles, 4 radial and 4 interradial. Later there are 4 radial clusters, each consisting of 2 tentacles, and 4 smaller, isolated, interradial tentacles. Medusa-buds are produced upon the interradial sides of the stomach, when the medusa has only 8 tentacles. The 4 oral tentacles remain simple and unbranched throughout life.

*Lizzia elizabethæ* Haeckel resembles *R. blondina* in all respects excepting that there are 4 tentacles in each radial, and 2 in each interradial cluster. Haeckel found this at Jersey, English Channel. May it not be *R. blondina* with more than the usual number of tentacles?

Browne found a 3-rayed specimen of *R. blondina*, with 3 radial-canals, 3 oral tentacles 3 clusters of "perradial" tentacles each containing 2 tentacles and 3 single interradial tentacles

### Genus CHIARELLA Maas, 1897.

*Chiarella*, Maas, 1897, Mem. Mus. Comp. Zool. at Harvard College, vol. 23, p. 15.

The type species and the only known form is *Chiarella centripetalis* Maas, from the Gulf of California, Pacific coast of Mexico.

#### GENERIC CHARACTERS.

Margelinæ in which the ring-canal gives rise to blindly ending, centripetal diverticula, There are 8 cleft tentacle-clusters, so that the tentacles arise from 16 epaulet-shaped, marginal swellings. 4 of these cleft tentacle-clusters are radial, and 4 interradial in position. The oral tentacles are dichotomously branched.

This genus is chiefly distinguished by the blindly-ending diverticula of the marginal ring-canal. The deeply-cleft tentacle-epaulets are quite characteristic, but this tendency is also seen in some species of *Bougainvillia* and can not be considered as being a distinguishing characteristic of *Chiarella*, although it appears in a more marked degree in *Chiarella* than in *Bougainvillia*.

### Chiarella centripetalis Maas.

*Chiarella centripetalis*, Maas, 1897, Mem. Mus. Comp. Zool. at Harvard College, vol. 23, p. 15, taf. 2, fign. 1–4; 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 13.

Bell high and dome-like, 15 to 20 mm. high, 10 to 15 mm. wide. Gelatinous substance of slight consistency and fairly thick at apex, but thin at margin. Velum small. Bell-margin exhibits 8 adradial, lappet-like emarginations which alternate with the radial and interradial clusters of tentacles. The tentacles are very short, not more than one-tenth as long as the bell-height and arising from 8 medianly cleft, marginal, epaulet-shaped swellings. The median cleft in each tentacle-epaulet is so deep that the epaulet seems divided. 4 of these divided epaulets are radial and 4 interradial in position. In the mature medusa there are somewhat more than 40 tentacles in a single row on each double-epaulet, the medusa having altogether about 320 tentacles. These tentacles arise side by side from the margin of the epaulets, and the line of tentacles is continuous and not interrupted at the median cleft. There is an ocellus upon the margin of the epaulet, on the velar side, at the base of each tentacle.

There are 4 straight-edged, narrow radial-canals and a ring-canal. This ring-canal gives off a short, pointed, blindly ending, centripetal diverticulum in each interradius above the median cleft of each interradial tentacle-epaulet.

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The stomach is barrel-shaped and about one-fifth as wide as the bell-diameter. It is not quite half as long as the depth of the bell-cavity and is mounted upon a very short peduncle down which the 4 radial-canals extend to the base of the stomach. There are 4 radially placed clusters of oral tentacles. Each cluster arises from a single stalk which branches dichotomously 5 to 6 times, thus giving somewhat more than 32 terminal ramuli in each quadrant. These terminal branches end in nematocyst-knobs.

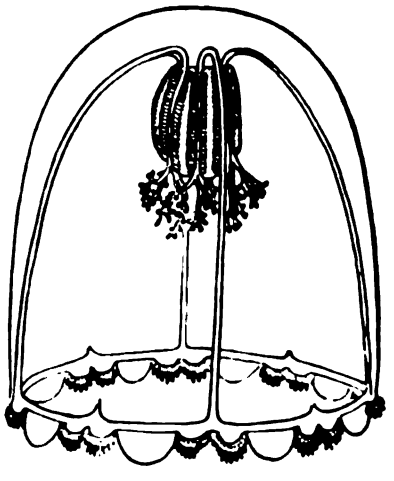

FIG. 96.—*Chiarella centripetalis*, after Maas, in Mem. Museum Comp. Zool. at Harvard College.

The gonads are 8 adradial, linear swellings along the sides of the barrel-shaped stomach.

The entoderm of the radial-canals and tentacle-bulbs is rose-red, as is also the deep-lying entoderm of the stomach. The gonads are dark-carmine and the ocelli dark-brown.

Found in the Gulf of California, Pacific coast of Mexico, by the *Albatross* in the spring of 1891.

### Subfamily DENDROSTAURINÆ, nov. subfam.

*Bythotiaridæ + Williadæ*, MAAS, 1904, Sitzungsber. math.-phys. Klasse kgl. Bayer. Akad. Wissenschaft., Bd. 34, pp. 437, 438; Craspedoten Medusen der *Siboga* Expedition, Monog. 10, pp. 15, 19.—Bigelow, 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 212.

*Cannotidæ* (in part), HAECKEL, 1879, Syst. der Medusen, p. 140.

#### SUBFAMILY CHARACTERS.

Dendrostaurinæ: Anthomedusæ with 4 or more primary radial-canals, some or all of which branch. The 4 lips are without oral tentacles. The gonads are upon the interradial, or adradial, sides of the stomach.

There are two tribes, Bythotiaridi and Williadi.

The tribe Bythotiaridi was established by Maas, 1904, as the family Bythotiaridæ (Sitzungsber. math.-phys. Klasse kgl. Bayer. Akad. Wissenschaft., Bd. 34, p. 437; also, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 15). Maas pointed out its relationship to the Tiarinæ, which are exhibited most completely in the genus *Bythotiara* Günther, wherein the gonads are exactly similar to those of the Tiarinæ, the only essential difference being the branched radial-canals.

The tribe Williadi as we define it is equivalent to the family Williadæ of Forbes, Agassiz, Haeckel, Browne, Maas, and others.

In 1904, *loc. cit.*, Maas showed that the Cannotidæ of Haeckel, 1879, was a heterogeneous group composed of both Anthomedusæ and Leptomedusæ, and is, therefore, purely artificial and must be abandoned.

We will now proceed to define the tribes Bythotiaridi and Williadi and their genera.

#### CHARACTERS OF THE TRIBE BYTHOTIARIDI.

Dendrostaurinæ with branching radial-canals and a ring-canal. Without clusters of nematocysts upon the exumbrella above the margin between the tentacles. With hollow tentacles situated at the ends of the branches of the radial-canals. The gonads are confined to the interradial sides of the stomach.

The Bythotiaridi are separated from the Williadi by the presence of a ring-canal and the absence of clusters of nematocysts upon the exumbrella.

In the genera *Bythotiara* and *Sibogita* the gonads are similar to those of the Amphinemidi and Pandæidi of the Tiarinæ, for they consist of ridges in the ectoderm of the interradial sides of the stomach. Unfortunately the development of these medusæ is unknown, although a peculiar process of budding takes place in the tentacle-bulbs of *Niobia* and the same medusa is known to cast its eggs out into the water.

The genera of the tribe Bythotiaridi are as follows: *Bythotiara* Günther, 1903; with 4 radial-canals which bifurcate so that 8 canals reach the circular vessel. 8 marginal tentacles,

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one at the end of each terminal branch of the radial-canals. Gonads in 4 interradial ridges on the sides of the stomach. Manubrium with 4 simple lips. A single specimen found by Günther at a depth of 1,610 fathoms, N. lat. 52° 18.1′, W. long. 15° 53.9′.

*Sibogita* Maas, 1904; with 4 principal radial-canals. Centripetal vessels arise from the ring-canal and fuse with the 4 radial-canals. These canals are of various calibers. The tentacles are hollow. The gonads are developed upon the 4 interradial sides of the manubrium in the form of a double row of transverse ridges in each quadrant. There are 4 simple lips.

*S. geometrica* Maas, 1905 (Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 17, taf. 3, fign. 16–18.) A single specimen was found near the Celebes, Malay Archipelago. *S. simulans* Bigelow, 1909, from the Eastern Pacific.

*Niobia* Mayer, 1900; with 4 main radial-canals, 2 of which bifurcate so that 6 radial-canals reach the circular vessel. The 4 gonads are developed upon the interradial sides of the stomach. The marginal tentacles develop into free-swimming medusæ. The only species is *N. dendrotentacula* of Tortugas, Florida.

Maas, 1904, is inclined to include the genera *Netocertoides* and *Dichotomia* among the Bythotiaridi, but in these genera the gonads extend outward along the radial-canals and there are solid interradial cirrus-like tentacles upon the bell-margin; they appear, therefore, to be Leptomedusæ.

## CHARACTERS OF THE TRIBE WILLIADI.

*Williadæ*, Forbes, 1848, British Naked-eyed Medusæ, p. 19.—Agassiz, A., 1865, North Amer. Acal., p. 171.—Haeckel, 1879, Syst. der Medusen, p. 156.—Browne, 1904 Fauna and Geog. Maldive and Laccadive Archipelagoes, vol. 2, Pt. 3, p. 724.—Maas, 1904, Sitzungsber. math.-phys. Klasse kgl. Bayer. Akad. der Wissenschaften, Bd. 34, p. 43; 1905, Craspedoten Medusen *Siboga* Expedition, p. 19.—Hartlaub, 1907, Nordisches Plankton, Nr. 12, p. 5.

*Berenicidæ* (sens. restr.), Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 345.

*Hydrolaridæ*, Allman, 1871, Monog. Tubularian Hydroids.—Delage et Herouard, 1901, Traité de Zool. Concrète, tome 2, Par. 2, Les Cœlentérés.

Dendrostaurinæ with 4 or more primary radial-canals which, during the growth of the medusa, give rise to one or more side branches. Stomach with 4 to 6 or more lobes upon the interradial sides of which the gonads are situated. The tentacles are simple and hollow and are situated at the ends of the main radial-canals and their branches. There are clusters of nematocysts upon the exumbrella above the margin between the tentacles, and there is no ring-canal. These last two characters serve to distinguish the Williadi from the closely allied tribe Bythotiaridi.

The tentacles are never grouped into clusters, but arise singly from the bell-margin. There are neither cirri nor sensory clubs upon the bell-margin. The successive development of side branches which arise from the main radial-canals is a distinguishing feature of this tribe.

It has been shown by Hincks, 1872, and Browne, 1896, that the medusa of *Willsia stellata* Forbes develops by alternation of generations from the hydroid *Lar sabellarum* of Gosse, 1857.

Brandt, 1838, and Browne 1904, found that there is no circular canal in *Proboscidactyla* and *Willsia*, and in 1904 Browne showed that there is a tube under the clusters of nematocysts of the exumbrella. Isolated nematocysts move along the bell-margin and then enter one of these tubes and stop, and thus a cluster is formed by the accumulation of nematocysts.

For the Williadi we adopt the classification of Browne and Maas in the sense in which they define the Williadæ. Thus:

*Proboscidactyla*, Brandt, 1835. Williadi in which 4 primary radial-canals leave the stomach.

*Willsia*, Forbes, 1846, with 6 or more primary radial-canals leaving the stomach. The hydroid of *W. stellata* is *Lar sabellarum*.

It appears from researches of Hincks 1872, Browne 1896, 1904, and Maas 1904, that the Williadi belong among the Anthomedusæ and not, as stated by Haeckel, among the Leptomedusæ. For Browne, 1896 (Proc. Zool. Soc. London for 1896, p. 468), demonstrates that the medusa of *Willsia stellata* Forbes is derived from a hydroid which was first described by Gosse, 1857, under the name of *Lar sabellarum*. The best description of *Lar sabellarum* has however, been given by Hincks, 1872 (Ann. and Mag. Nat. Hist., ser. 4, vol. 10, p. 313, plate 19). The polypites are of two sorts and arise from a creeping hydrorhiza which is found grow-

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ing upon the tube of *Sabella*. The sterile feeding-polypites are fusiform and have but 2 tentacles, which arise from one side of the body. The reproductive polypites, or blastostyles, are mouthless and cylindrical in shape. Their free distal end terminates in a knob-like cluster of nematocysts. Several medusa-buds arise in a cluster from the side of the blastostyle. The medusæ become free and develop into *Willsia stellata* of Forbes, 1848 (p. 19, plate 1, fig. 1).

### Tribe BYTHOTIARIDI.

### Genus BYTHOTIARA Günther, 1903.

*Bythotiara*, GÜNTHER, 1903, Annals and Mag. Nat. Hist., ser. 7, vol. 11, p. 424. MAAS, 1905, Craspedoten Medusen der *Siboga* Exped., Monog. 10, p. 18.

The type species is *Bythotiara murrayi* Günther, from a depth of 1,610 fathoms, off the southwest coast of Ireland.

#### GENERIC CHARACTERS.

With 4 (to 5?) radial-canals some or all of which bifurcate so that 8 (to 10?) canals reach the circular vessel at the margin. Tentacles at the extremities of the terminal branches of the radial-canals. 4 interradial gonads, in the form of swollen ridges on the sides of the stomach. 4 (or 5?) simple lips. No longitudinal nematocyst tracts upon the exumbrella.

#### Bythotiara murrayi Günther.

*Bythotiara murrayi*, GÜNTHER, 1903, Annals and Mag. Nat. Hist., ser. 7, vol. 11, p. 424, plate 10, figs. 4, 5.

Medusa 7 mm. in diameter. 8 long tentacles at the bases of the 8 terminal branches of the radial-canals. 4 radial-canals which bifurcate close to the manubrium, giving 8 terminal

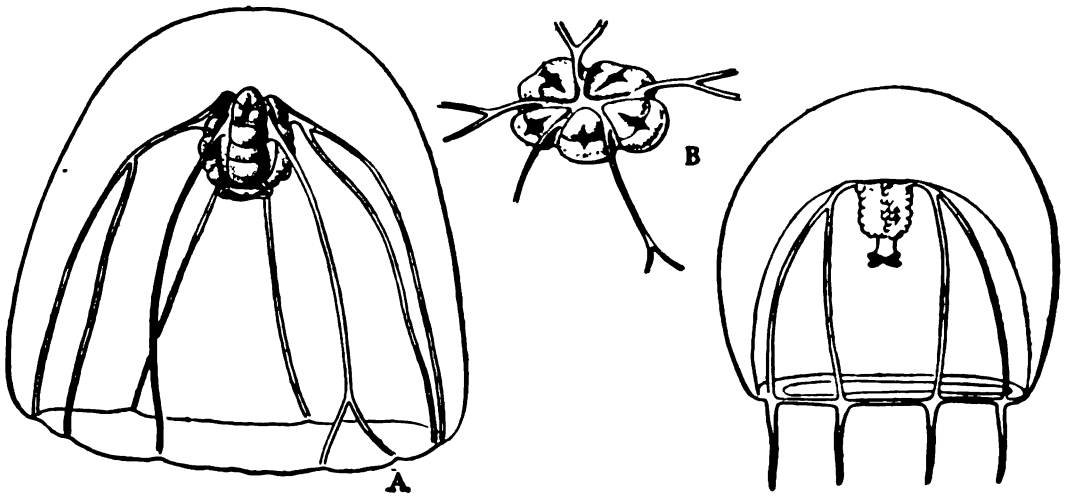


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FIG. 97.—*Bythotiara murrayi*. After Günther, Annals and Mag. Nat. Hist.
FIG. 98.—*Bythotiara murrayi*. *A*. Side view. *B*. Aboral view of manubrium. From a specimen in the *Puritan* collection, No. 46, 1902; at the Stazione Zoologica, Naples. Drawn by the author.

branches. 4 lips. Gonads in 4 ridges along the interradial angles of the stomach. Color (?) A single specimen from a depth of 1,610 fathoms in N. lat. 52° 18.1′, W. long. 15° 53.9′, off the southwest coast of Ireland. Dr. Lobianco of the Naples Station kindly permitted me to study a specimen of this, or a closely allied medusa which was obtained by the Krupp yacht *Puritan* from a depth of 1,000 fathoms near Capri, Bay of Naples, and is now preserved in alcohol at the Naples Zoological Station (fig. 98). The bell is dome-shaped, 12 mm. high and 14 mm. wide and flattened laterally. The bell-margin is destroyed. 5 primary radial-canals arise from the stomach and 4 of these bifurcate, the other canal being simple. Thus 9 canals extend to the periphery of the bell. The stomach is 2.5 mm. long and there are 5 inter-

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radial, swollen gonads, with transverse furrows and a longitudinal median groove. I believe this to be identical with Günther's medusa. Having 5 primary radial-canals it may be abnormal.

### Genus SIBOGITA Maas, 1905; sens. emend Bigelow, 1909.

*Sibogita*, MAAS, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 16.—BIGELOW, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 213.

The type species is *Sibogita geometrica* Maas, from the Malay Archipelago.

#### GENERIC CHARACTERS.

Bythotiaridi with 4 main radial-canals. The marginal ring-canal gives off a number of centripetal canals which in young specimens end blindly, but in later stages they connect with the cruciform base of the stomach. The gonads consist of a pair of ridges with cross furrows on each of the 4 interradial sides of the stomach. The tentacles are hollow and are situated at the ends of the larger canals.

It is probable that this genus has been phylogenetically derived from some Turris-like medusa.

### Sibogita geometrica Maas.

*Sibogita geometrica*, MAAS, 1905, Craspedoten Medusen der *Siboga* Exped., Monog. 10, p. 17, taf. 3, fign. 16–18.

Bell is 40 mm. high, 20 mm. wide; with bulging, laterally flattened, barrel-shaped sides and flatly rounded top. Gelatinous substance uniform and quite thick. There are 16 slender, hollow tentacles, with swollen, club-like outer ends. These tentacles arise from the ring-canal at the bases of the 16 larger canals and they project from the sides of the bell at a short distance above the margin, as in Narcomedusæ. The entodermal cores of the tentacles extend through the gelatinous substance of the bell to the ring-canal, and the margin between the tentacles is thrown into 16 gelatinous "lappets." The tentacles are about three-fourths as long as the bell-height, but are highly contractile. Their bases are only slightly swollen and there are no ocelli.

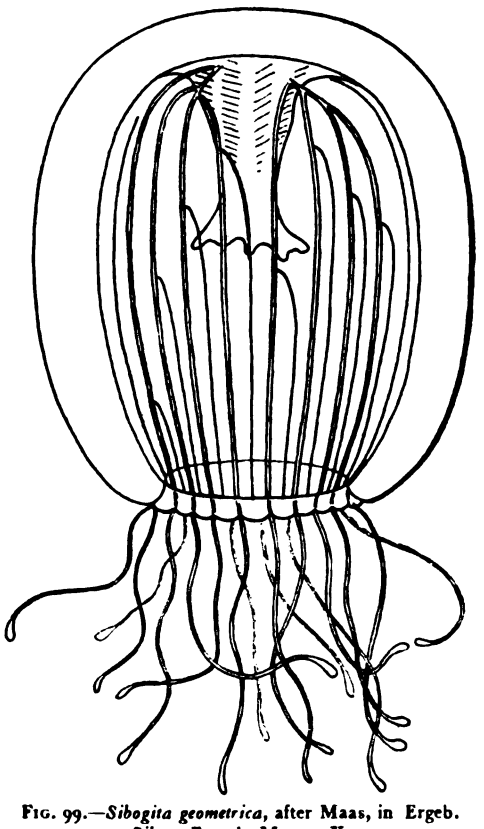

FIG. 99.—*Sibogita geometrica*, after Maas, in Ergeb. *Siboga* Exped., Monog. X.

There is a marginal ring-canal which gives rise to centripetal branches. According to Maas, 4 wide, main radial-canals arise from the 4 corners of the stomach and proceed straight to the ring-canal. 2 or 3 alternately arranged branches fuse with the sides of each of these main radial-canals. The largest (oldest?) branches are nearest the corners of the stomach, while the branches which fuse with the more peripheral parts of the main canals are smaller as we proceed outward. Altogether about 28 centripetal vessels arise from the ring-canal. The 4 main radial-canals are of large caliber, but the centripetal vessels are narrower in accordance with their age, the latest formed being narrowest. Dr. H. B. Bigelow has shown that the "side branches" of Maas are actually centripetal vessels which arise from the ring-canal and only later in life join the radial-canals.

The stomach lacks a peduncle and is narrow and about half as long as the depth of the bell-cavity. It is 4-sided at its base and the 4 lips are flaring with folded edges. There is a throat-tube

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## Plate 19.

Fig. 1. *Niobia dendrotentacula*, young medusa immediately after being set free from the parent. Tortugas, Florida, May, 1899.

Fig. 2. *Niobia dendrotentacula.* Side view of medusa showing the manner in which the tentacles develop into medusæ.

Fig. 3. *Niobia dendrotentacula.* View of manubrium of mature medusa after the budding process has ceased and the ova become mature.

Fig. 4. *Niobia dendrotentacula.* Diagram showing the sequence in which the medusa buds are set free from the parent medusa; "1" is set free first, "7" last.

Fig. 5. *Niobia dendrotentacula.* Oral view showing the order in which medusa buds are developed at the tentacle-bases. Tortugas, Florida, May 25, 1899.

Drawn from life, by the author.

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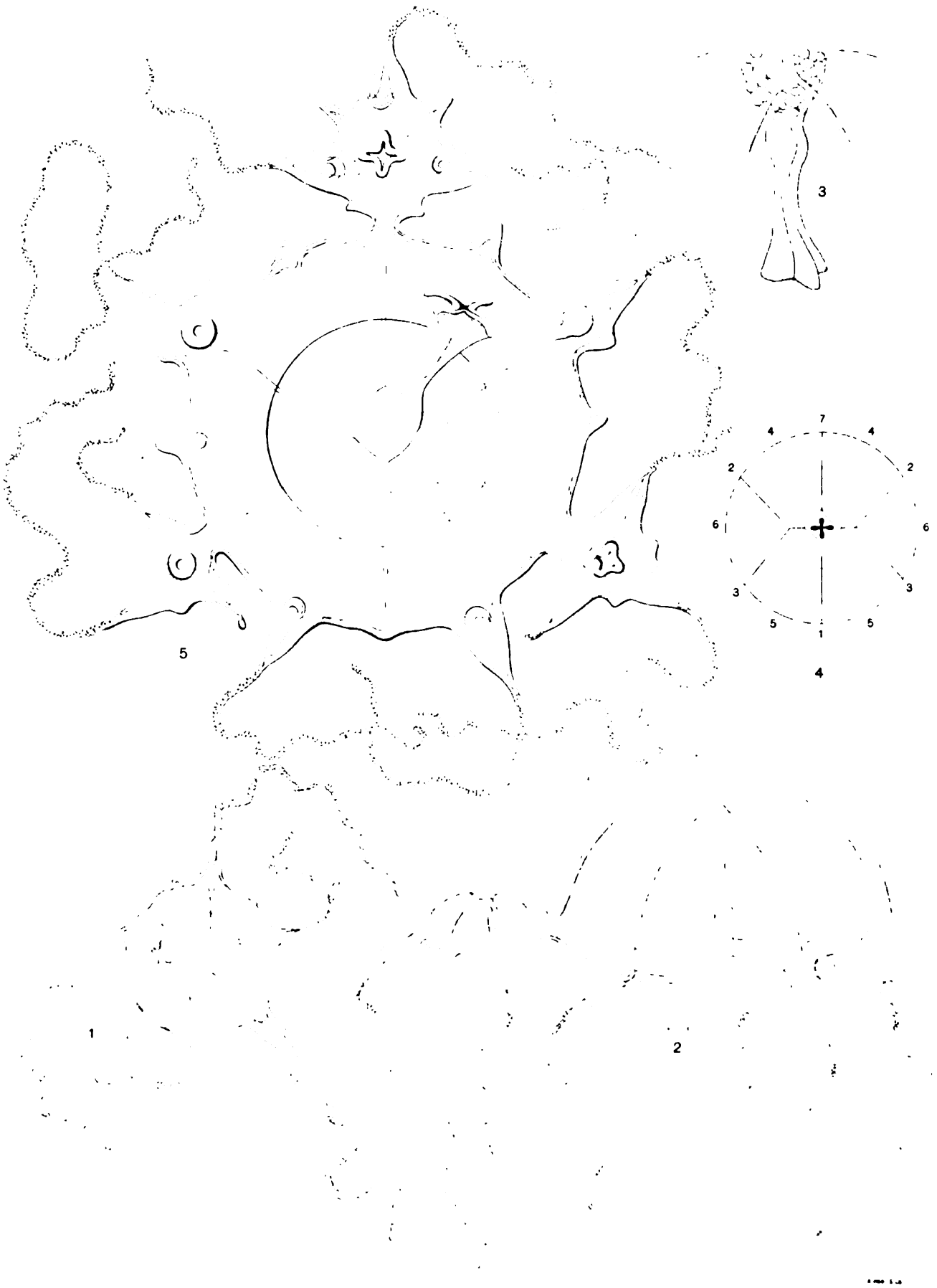


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above the mouth and the stomach is urn-shaped and cruciform in cross-section. The 4 gonads are on the interradial sides of the basal part of the stomach and consist of 2 bow-like longitudinal ridges in each interradius. These ridges are crossed by furrows as in Tiarinæ.

The entodermal parts are brown or almost black, but this color may be due in some measure, if not wholly, to the method of preservation.

A single preserved specimen is described by Maas. It was captured in an open vertical net between 450 fathoms and the surface, in the Malay Archipelago, near the Celebes, in 1° 38′ N. lat., 124° 28.2′ E. long.

### Sibogita simulans Bigelow.

*Sibogita simulans*, BIGELOW, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 213, plates 5, 41, and 43.

This medusa may prove to be identical with *S. geometrica* Maas.

Bell 30 mm. high, 22 mm. wide, laterally flattened, apex dome-like and rounded, gelatinous substance thick. Manubrium barrel-shaped, one-third as long as depth of bell-cavity. Its base is 4-sided. 4 interradial gonads each consisting of a double, transverse row of folds on the sides of the stomach. Lips well developed. There are 4 main radial-canals. In young medusæ the ring-canal gives rise to 8 adradial, blindly ending centripetal vessels. In later life these adradial vessels connect with the stomach and 4 new interradial vessels make their appearance and also connect with the stomach. Thus the medusa has 4 radial-canals and 12 vessels which arise from the marginal ring-canal and secondarily connect with the cruciform arms of the stomach. When mature there are 30 tentacles, one opposite each canal and the others somewhat irregularly arranged. The tentacles are long, hollow, and flexible and terminate in a knob of nematocysts. They have no basal bulbs and no ocelli.

The gonads are reddish-brown; bell faint blue.

2 specimens were found on the surface in the tropical Pacific between the Galapagos Islands and Panama; another from Behring Sea, 121 fathoms.

## Genus NIOBIA Mayer, 1900.

*Niobia*, MAYER, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 36.

### GENERIC CHARACTERS.

Dendrostaurinæ with 4 main radial-canals, 2 of which bifurcate, so that 6 canals reach the circular vessel at the bell-margin. The gonads are developed on the 4 interradial sides of the stomach. The mature genital products are found in the ectoderm. There are 4 simple lips, but no oral tentacles. The marginal tentacles develop into medusæ by a peculiar process of budding combined with fortuitous growth and are set free into the water as independent animals similar to the parent medusa.

The only known species is *Niobia dendrotentacula* of the Tortugas, Florida.

### Niobia dendrotentacula Mayer.

Plate 19, figs. 1-5.

*Niobia dendrotentacula*, MAYER, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 36, figs. 141-144, plates 42, 43.

*Adult medusa* (plate 19, fig. 5).—The bell is slightly flatter than a hemisphere and about 4 mm. in diameter. The outer surface is smooth and there is no apical projection. The gelatinous substance of the bell is quite thin and uniform, but not very flexible.

4 radial-canals arise from the 4 corners of the stomach; but 2 of these canals, which are diametrically opposite each other, bifurcate so that 6 radial-canals reach the circular vessel at the margin, 60° apart.

There are 12 marginal tentacles, one at the foot of each radial-canal and one intermediate between each successive pair of radial-canals. These 12 tentacles are arranged in a bilaterally symmetrical manner in accordance with age. The oldest and the youngest tentacles are situated at the ends of the 2 simple radial-canals and the remaining 10 tentacles are arranged in bilateral symmetry in accordance with their various ages, the axis being in the diameter of the 2 simple radial-canals and the oldest and youngest tentacles. Each half of the margin is thus a reflection of the other, and the order in age of each tentacle is shown in plate 19, fig. 4, where (1) represents the oldest, (2) the next oldest, and (7) the youngest



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and least-developed tentacles. Thus tentacles (1) and (7), the oldest and youngest, are situated at the ends of the two simple radial-canals, while tentacles (2, 2) and (3, 3), the second and third in order of age, are found at the bases of the two forked canals. In addition to these there are the interradial sets of tentacles (4, 4), (5, 5) and (6, 6) in order of age; and thus the medusa has 12 tentacles, 6 radial and 6 interradial.

It is remarkable that through a peculiar process of growth and budding each tentacle-bulb is successively developed into a small medusa which resembles the adult and is set free into the water. The oldest tentacle is the first to develop into a medusa and be set free, and the others follow in the order of their age until all of the tentacles have been cast off. They are immediately replaced, however, by new tentacles, but after every one of the original 12 tentacles has been developed into a new medusa, the process of forming medusæ declines and finally ceases, and then the parent medusa becomes sexually mature.

The first stage in the transformation of a tentacle-bulb into a new medusa is the appearance of a hernia-like outgrowth upon the floor of the subumbrella close to the tentacle-bulb. This hernia-like projection, which is composed of both ectoderm and entoderm and has its cavity connected with a radial-canal or the circular vessel of the medusa, is destined to form the manubrium of the new medusa. Soon after it begins to develop 2 pointed outgrowths appear on the sides of the adjacent tentacle-bulb and these soon develop into new tentacles. These outgrowing tentacles become larger and soon a still younger pair appear farther out on the side of the original tentacle-bulb and these are soon followed by another pair of tentacles, between the original pair of side branches and the margin of the medusa. Before this has taken place, however, 4 short canals (the bifurcated radial-canals of the future medusa) develop and the circular canal completes its circuit by coalescence.

An opening then appears in the velum of the parent medusa immediately below the manubrium of the developing medusa and this constitutes the velar opening of the new animal. The manubrium becomes cruciform in cross-section and finally the new medusa is constricted off and is set free with 6 radial-canals, 5 well-developed and 6 small, immature tentacles and a velum (plate 19, fig. 1). Even before the young medusa is cast off a hernia-like outgrowth has developed near the base of its oldest tentacle preparatory to a repetition of the process of budding. In this remarkable process of budding we see that the simple radial-canals, the ring-canal, the velum, and the oldest tentacle are stolen directly, so to speak, from the parent medusa. The forked canals, manubrium, and younger tentacles are new growths, and thus the bud is not compelled to develop all of its organs anew. The budded medusæ are very hardy when detached and swim actively about, and soon develop new medusæ out of their tentacle-bulbs.

The manubrium of the mature medusa is about as long as the depth of the bell-cavity. There is an enlargement near the middle of its length; the 4 simple lips are well developed and cruciform. The gonads occupy 4 interradial situations in the upper part of the ectodermal wall of the stomach. After the budding medusæ have been set free the gonads become mature and the ova are large and project from the interradial surfaces of the stomach. They are finally dehisced into the water. The entoderm of the manubrium, tentacle-bulbs, and circular canal is ocher-yellow, all other parts being transparent.

This medusa was abundant at Tortugas, Florida, from May 21 to June 4, 1899; and a few have been found early in June of every subsequent year. It is very active and thrives well in confinement.

### Tribe WILLIADI.

### Genus PROBOSCIDACTYLA Brandt, 1838.

*Proboscidactyla*, Brandt, 1838, Mém. Acad. Imp. St. Pétersbourg, Sci. Nat., sér. 6, tome 4, p. 390.—Browne, 1904, Hydromedusæ Maldive Islands, p. 725; 1905, Ceylon Pearl Oyster Report No. 27, Medusæ, p. 135.—Maas, 1904, Sitzungsber, math.-phys. Klasse kgl. Bayer. Akad. Wissenschaften, Bd. 34, p. 438; 1905, Hydromedusen der *Siboga* Expedition. p. 20—Bigelow, H. B., 1909, Mem. Museum Comp. Zool. at Harvard College, vol. 37, p. 218.

*Willsia*, McCrady, 1857, Gymn. Charleston Harbor, p. 47.

*Willia*, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 346.—Agassiz, A., 1865, North Amer. Acal., p. 171.—Verrill, 1873, Report Commiss. Fish and Fisheries for 1871–72, p. 735.

*Dyscannota + Dicranocanna + Willetta + Proboscidactyla*, Haeckel, 1879, Syst. der Medusen, pp. 151, 156, 157, 159.

*Willia*, Fewkes, 1882, Bull. Mus. Comp. Zool. at Harvard College, vol. 9, No. 8, p. 299; 1884, Mem. Mus. Comp. Zool. at Harvard College, vol. 9, No. 3, plate 5, fig. 19.

*Willsia*, Huxley, 1891, Anatomy of Invertebrated Animals, p. 120.

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PLATE 20.

Figs. 1, 2, and 3. *Proboscidactyla ornata*, young medusæ. Agassiz Laboratory, Newport, Rhode Island, June, 1892.

Fig. 4. *Proboscidactyla ornata*, young medusa with tentacles expanded. Agassiz Laboratory, Newport, Rhode Island, July 3, 1893.

Fig. 5. Part of a tentacle of the medusa shown in figure 4.

Fig. 6. *Proboscidactyla ornata*, young medusa having 8 terminal branches to the radial-canals. Agassiz Laboratory, Newport, Rhode Island, July, 1892.

Figs. 7 and 8. *Proboscidactyla ornata*, young medusæ showing variations in color. Agassiz Laboratory, Newport, Rhode Island, July 26, 1895.

Fig. 9. *Proboscidactyla ornata*, mature female in which the radial-canals have 12 terminal branches. Agassiz Laboratory, Newport, Rhode Island, September 17, 1896.

Fig. 10. *Proboscidactyla ornata*. Oral view of a mature female in which the radial-canals have 16 terminal branches. Agassiz Laboratory, Newport, Rhode Island, September 12, 1892.

Fig. 11. *Rathkea octopunctata*. Half-grown budding medusa. Abundant among masses of floating ice in the harbor. Woods Hole, Massachusetts, March 4, 1907.

See page 178 for description of figure 11.

Drawn from life, by the author.

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The type species of this genus is *Proboscidactyla flavicirrata* Brandt, from the North Pacific. Its 4 main radial-canals branch more profusely than in any other species of the genus.

The American species, *P. ornata*, was first described by McCrady under the name *Willsia ornata* from Charleston Harbor, South Carolina.

### GENERIC CHARACTERS.

*Proboscidactyla:* Dendrostaurinæ having 4 primary radial-canals which give rise to simple, or branched, side branches during the growth of the medusa. The tentacles are simple and hollow and are situated at the extremities of the radial-canals and their branches. Upon the exumbrella there are clusters of nematocysts which alternate in position with the tentacles. There are no marginal clubs or cirri and there is no circular canal. The gonads are upon the 8 adradial sides of the stomach extending outward along the sides of the 4 radial-canals.

Haeckel, 1879, separates that which we here designate as *Proboscidactyla* into 4 genera as follows:

1. *Dicranocanna*, in which the 4 radial-canals branch once, giving 8 radial vessels which reach the bell-margin.
2. *Dyscannota*, in which the 4 primary radial-canals give rise each to 2 side branches, and thus 12 canals reach the bell-margin.
3. *Willetta*, in which the 4 original radial-canals give rise each to 2 side branches, and the first-formed side branch of each quadrant itself gives rise to a side branch, so that 16 canals reach the bell-margin.
4. *Proboscidactyla*, in which the 4 canals that rise from the stomach branch complexly, and branches arise from the primary branches, etc., so that 32 or more radiating canals reach the bell-margin.

It is evident that medusæ of the genus *Proboscidactyla* may successively pass through stages represented by the genera *Dicranocanna*, *Dyscannota*, and *Willetta*.

The American, Atlantic *Proboscidactyla ornata* is sexually mature in the "*Willetta*" stage, but its southern variety *gemmifera* gives rise to medusa-buds while in the "*Dyscannota*" stage.

*Psythia prolifera*, Agassiz and Mayer, 1902, Mem. Museum Comp. Zool. at Harvard College, vol. 26, p. 143, plate 1, fig. 3, may be a young budding *Proboscidactyla?*

#### Proboscidactyla flavicirrata Brandt.

*Proboscidactyla flavicirrata*, Brandt, 1834, Recueil Actes séances publiques Acad. Imp. Sci. St. Pétersbourg, p. 28 (of the "Separate"); 1838, Mém. Acad. Imp. Sci. St. Pétersbourg, Sci. Nat., sér. 6, tome 4, Par. 2, p. 390, plate 19.—Agassiz, A., 1865, North Amer. Acal., p. 173, figs. 280–282.—Browne, 1904, Fauna and Geography Maldive and Laccadive Archipelagoes, vol. 2, p. 725.—Bedot, 1905, Revue Suisse de Zool., tome 13, p. 144 (all papers to 1850).
*Proboscidactyla flavicirrata + P. brevicirrata*, Haeckel, 1879, Syst. der Medusen, pp. 159, 160.
*Proboscidactyla brevicirrata*, Murbach and Shearer, 1903, Proc. Zool. Soc. London, vol. 2, p. 178.

Bell thick-walled and dome-like to globular. About 12 mm. wide and 10 mm. high. 4 main radial-canals arise from the stomach, but these fork near their points of origin and each branch gives rise to side branches, from one side only and these again give off similarly arranged branches so that about 54 to 70+ terminal branches reach the bell-margin. There is a short tentacle at the end of each terminal branch of the radial-canals. There are clusters of nematocysts on the exumbrella alternating with the tentacles. There is no ring-canal. Stomach small, with 4 recurved lips. Gonads upon the sides of the 4 radial pouches of the stomach. There are neither medusa-buds nor stolons.

Stomach, gonads, and tentacle-bulbs dull yellow. North Pacific, coast of Kamtschatka and Puget Sound, Washington.

This species is distinguished by the profuse and peculiar branching of its radial-canals.

#### Proboscidactyla ornata Browne.

Plate 20, figs. 1–10.

*Willsia ornata*, McCrady, 1857, Gymn. Charleston Harbor, p. 47, plate 9, figs. 9–11.
*Willia ornata*, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 346. Agassiz, A., 1862, Proc. Boston Soc. Nat. Hist., vol. 9, p. 96, figs. 20, 21; 1865, North Amer. Acal., p. 171, figs. 274*a*–279.—Verrill, 1873, Report Commiss. Fish and Fisheries U. S. for 1871–72, pp. 455, 735.—Fewkes, 1882, Bull. Mus. Comp. Zool. at Harvard College, vol. 9, p. 299, figs. 22, 23, *non* fig. 24; 1884, Mem. Mus. Comp. Zool. at Harvard College, vol. 9, No. 3, plate 5, fig. 19.—Mayer, 1904, Mem. Nat. Sci. Museum Brooklyn Inst. Arts and Sci., vol. 1, No. 1, p. 13, plate 2, fig. 12.—Nutting, 1901, Bull. U. S. Fish Commission for 1899, vol. 19, p. 377.—Hargitt, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 40, plate 1, fig. 5.
*Dyscannota dysdipleura*, Haeckel, 1879, Syst. der Medusen, p. 152.
*Willetta ornata*, Haeckel, 1879, Syst. der Medusen, p. 157.
*Proboscydactyla ornata*, Browne, 1904, Hydromedusæ Maldive Islands, p. 726.—Maas, 1904, Sitzungsber. math.-phys. Klasse kgl. Bayer. Akad. Wissenschaft., Bd. 34, p. 439.
(?) *Dicranocanna furcillata*, Haeckel, 1879, Syst. der Medusen, p. 156.

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*Sexually-mature medusa* (plate 20, figs. 9 and 10).—Bell about 5 mm. in diameter and slightly higher than a hemisphere with flaring, bell-shaped sides. Gelatinous substance thick and rigid. There are 16 marginal tentacles, one at the foot of each terminal branch of the radial-canals. 4 of these tentacles are at the ends of the 4 primary radial-canals. 4 younger tentacles are at the extremities of the secondary, 4 still smaller tentacles at the ends of the tertiary, and 4 more at the ends of the quarternary canals. There are thus 16 marginal tentacles, 4 in each quadrant. The tentacle-bulbs are large and hollow and their entoderm is densely pigmented. The shafts of the tentacles are very contractile and capable of great elongation. They are covered with ring-like clusters of nematocysts, which become apparent only during periods of contraction. There are neither marginal clubs nor cirri, but midway between the tentacles, immediately under the surface of the exumbrella, are 16 slender, centripetal canals which alternate with the tentacular radii in position. One or more clusters of nematocyst-cells are found upon the exumbrella immediately over each of these canals, and according to Browne, 1904, these nematocysts travel singly up the canals from the bell-margin and become lodged at intervals, forming accumulations.

4 main radial-canals arise from the 4 radial corners of the stomach. Each of these canals gives rise to 2 side branches and the longest and oldest of these side branches also gives rise to a side branch. Thus there are 16 terminal branches each one of which ends in the cavity of a tentacle-bulb. There is no ring-canal, but only a solid cord of entodermal cells connecting the tentacle-bulbs one with another. The manubrium is flask-shaped and the mouth is nearly at the level of the velar opening. There are 4 radially arranged, recurved lips with crenated edges. The 4 gonads are developed upon the 4 interradial sides of the

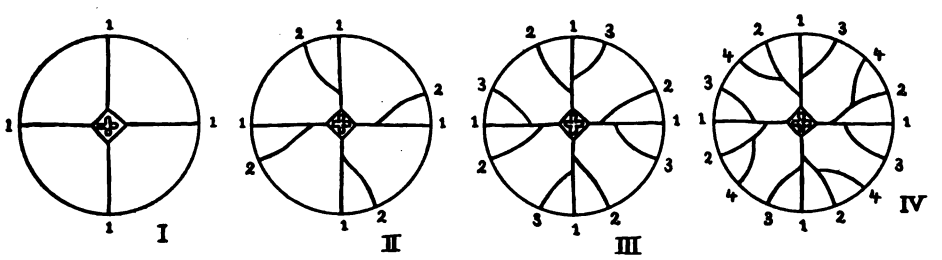


FIG. 100.—Diagrammatic oral views showing order of development of radial-canals in *Proboscidactyla ornata*. I, youngest stage; IV, mature condition.

stomach. In the female the mature ova are large and prominent. The entoderm of the stomach and gonads is ocher-yellow or greenish-yellow, while the entoderm of the tentacle-bulbs is crowded with brownish pigment granules. In the very young medusa, however, the entoderm of the manubrium and tentacle-bulbs is often pink.

*Young medusa.*—The hydroid of our American species has not been observed. In the youngest medusæ seen by me, the bell is about 0.7 mm. in diameter (plate 20, figs. 1–4). The gelatinous substance is relatively thinner than it is in the adult. There are 4 equally developed tentacles, capable of much expansion (fig. 4), but these are usually seen contracted in captive specimens. These tentacles are situated at the bases of the 4 primary radial tubes. 4 slender, blindly-ending, centripetal canals arise from the margin midway between the 4 tentacles, and there is a cluster of nematocyst-cells upon the exumbrella immediately over each canal. The manubrium is a simple, short tube with 4 well-developed, quadratic lips. The condition of the medusa in this stage is represented in text-figure 100, I, which represents an oral view of the animal.

When the medusa is about 1.25 mm. in diameter (plate 20, fig. 6), a side branch arises from each of the 4 primitive radial-canals, and at the same time a second set of tentacles (2222, text-figure 100, II) make their appearance. These new tentacles are about 22° 30′ away from the primary tentacles (1111). If one face the oral surface of the medusa, as is shown in text-fig. 100, it will be seen that the secondary tentacles (2222) lie in positions opposite to that of the hands of a watch relatively to the primary tentacles.

The third set of radial-canals (3333, fig. 100, III) arise from the 4 primary canals beyond the origins of canals 2222. This takes place when the medusa is about 2 mm. in diameter.

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The fourth set of radial-canals (4444, fig. 100, IV) arise from the sides of the second set of canals. At the completion of this stage, the medusa has 16 canals and 16 marginal tentacles which are about 22° 30′ apart. This does not occur until the medusa is about 3.5 mm. in diameter (plate 20, fig. 4) and some individuals appear to become sexually mature before this stage is reached (plate 20, fig. 3).

This medusa is common in Narragansett and Buzzard's Bays on the southern coast of New England. It is rare, according to Brooks, at Beaufort, North Carolina. McCrady found a single mature specimen and I have found several in Charleston Harbor, South Carolina, and in the Bahamas and Tortugas. It has not been taken north of Cape Cod on the New England coast, but is found along the entire coast of North America from the Bahamas to southern New England. Bigelow, 1909, has demonstrated that there is a closely related budding variety in the tropical Pacific.

It is possible that "*Dicranocanna furcillata*," found by Haeckel off the Atlantic coast of Morocco, may be identified with *P. ornata*.

From South Carolina southward our *P. ornata* gives rise to a variety which produces medusa-buds upon stolons at the 4 radial corners of the stomach near the points of entrance of the 4 radial-canals, and Haeckel's medusa has stolons in these positions.

**Proboscidactyla ornata var. stolonifera Bigelow.**

(?) *Willsia*, *sp.*, Huxley, 1877, Manual of Anatomy of Invertebrated Animals, London, p. 120, fig. 17.

(?) *Proboscidactyla tropica*, Browne, 1904, Fauna and Geog. of Maldive and Laccadive Archipelagoes, vol. 2, part 3, Hydromedusæ, p. 727.

*Proboscidactyla flavicirrata var. stolonifera*, Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, p. 21, taf. 4, fign. 24–28; 1906, Revue Suisse de Zool., tome 14, p. 89.

*Proboscidactyla ornata*, var. *stolonifera*, Bigelow, H. B., 1909, Mem Mus. Comp. Zool. at Harvard College, vol. 37, p. 220, plates 6, 41.

Bell rounded, 5 mm. wide, 4 mm. high, with a low, dome-like, apical projection and thin walls. 12 to 20 or more tentacles, one at the base of each terminal branch of the 4 main radial-canals. These tentacles are about as long as the bell-radius and have large, spherical basal bulbs which bear entodermal pigment-granules. An equal number of meridional lines of nematocysts alternate with the tentacles. These are upon the exumbrella and extend from the margin about one-fifth to one-half the distance up the sides of the bell. There are a number of clusters of nettling cells upon each line. The axial line is composed of a core of entodermal cells which branch off from the solid cord of entodermal cells which constitute the degenerate "ring-canal."

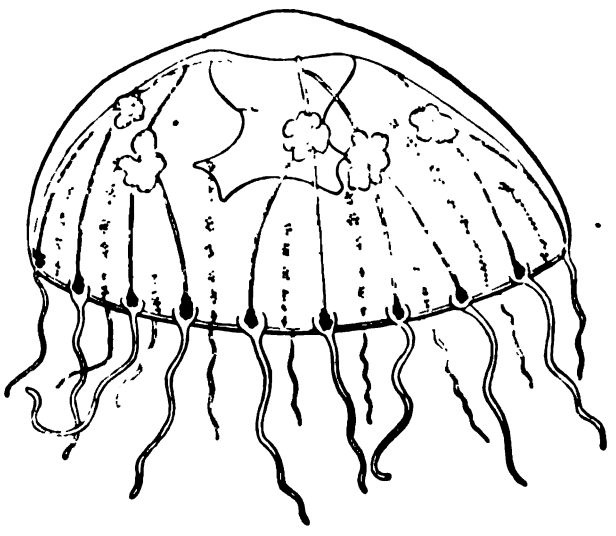

Fig. 101. *Proboscidactyla ornata var. stolonifera*, after Maas, in Ergeb. *Siboga* Exped., Monog. X.

The 4 main radial-canals branch quite irregularly after the second forking, so that 12 to 20, or more, canals reach the margin. The general mode of forking is, however, similar to that of *P. ornata*.

Medusa-bearing stolons develop at the second and third forkings of each of the 4 radial-canals. There are thus 8 of these stolons, 2 in each quadrant. These stolons do not all develop at one and the same time. The two oldest appear at the second forks of the canals of one diameter, then the next two at the second forks of the diameter 90° apart from the first, and then the 4 others follow in the same order at the third forkings of the canals.

The stomach is wide, cruciform, and urn-shaped, as in other species of the genus. The 4 lips are recurved, and the manubrium is not longer than one-half to two-thirds the depth

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of the bell-cavity. The gonads may be pale green or colorless. The entoderm of the tentacle-bulbs is black, or pale green, or colorless. The gonads are upon the sides of the stomach and extend even beyond the first bifurcations of the radial-canals. It is found in the Malay Archipelago, and at Acapulco, Pacific coast of Mexico.

This is identical with the medusa found by Huxley in the Louisiade Islands, North Pacific, and called *P. tropica* by Browne, 1904. In *P. "tropica,"* however, the medusa-bearing stolons arise from the *first* branchings of the 4 main canals and not from the second and third points of forking as in Maas' and Bigelow's form. Bigelow's studies have shown, however, that the two are identical, *P. tropica* being only a young stage.

*P. "tropica"* has 16 terminal branches to its 4 main radial-canals. 16 short tentacles, 4 stolons at the points of origin of the first branches of the 4 main radial-canals. These stolons are long and end in a knob of nematocysts. On one side the stolon gives rise to a series of medusa-buds, the oldest being nearest the free lower end of the stolon. When about to be set free the budding medusa has 4 simple, unbranched radial-canals and 4 tentacles.

**Proboscidactyla ornata var. gemmifera.**

Plate 21, figs. 1–3.

*Willia ornata*, Brooks, 1880, American Naturalist, vol. 14, p. 670; 1881, Studies Johns Hopkins Univ. Marine Lab., vol. 2, p. 144.
*Willia gemmifera*, Fewkes, 1882, Bull. Mus. Comp. Zool. at Harvard College, vol. 9, p. 300, plate 1, fig. 24.
*Proboscidactyla gemmifera*, Maas, 1904, Sitzungsber. math.-phys. Klasse kgl. Bayer. Akad. der Wissenschaften, Bd. 35, p. 439.—Browne, 1904, Hydromedusæ Maldive Islands, p. 727.
*Dyscannota gemmifera*, Mayer, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 47, plate 8, fig. 17.

This variety of *P. ornata* is peculiar in that it gives rise to medusa-buds which are borne upon 4 stolons that arise from the radial corners of the stomach near the points of origin of the 4 main radial-canals. Several medusa-buds in various stages of development may usually be seen upon each stolon. When set free, each medusa has 4 simple, unbranched radial-canals, 4 well-developed, radially situated tentacles, and 4 small, interradial tentacle-bulbs. There are also 8 centripetal canals alternating with and intermediate in position between the tentacle-bulbs and tentacles. There are no medusa-buds or stolons upon the medusæ when set free from the parent.

All of the budding specimens of *Proboscidactyla* which have thus far been observed were in the *Dyscannota* stage, having 12 terminal branches to the radial-canal system and 12 marginal tentacles. Each of the 4 canals which leave the stomach gives rise to 2 side branches, and thus there are 3 terminal canals in each quadrant; 12 in all. It is possible that after the medusa has ceased budding the canals may increase in number so as to become 16. On the other hand, *P. ornata* var. *gemmifera*, may never develop sex-cells or possess more than 12 canals. The common *P. ornata*, which lacks medusa-buds and has 16 tentacles and terminal canals, is found wherever the budding variety has been observed, although the budding variety is not known north of Beaufort, North Carolina, while the sexual form is abundant upon the southern coast of New England. For many years it was believed that in this *gemmifera* form there was constantly but a *single* cluster of nematocysts over each centripetal canal of the exumbrella, between the tentacles, whereas in the sexual *P. ornata* there might be 1, 2, or occasionally 3, clusters over each canal. In 1903, however, I found two specimens of the *gemmifera* form which had 1, 2, or 3 clusters of nematocysts over each centripetal canal, and therefore resembled the condition seen in the sexual *P. ornata*. No gonads have been observed upon the manubrium of the *gemmifera* form and the stomach is therefore smaller and more slender than in the sexual *P. ornata*.

*P. ornata* var. *gemmifera* is found from Beaufort, North Carolina, southward to the Bahamas. On the whole its close similarity to *P. ornata* in the *Dyscannota* stage leads me to believe that it is only an immature or budding variety of *Proboscidactyla ornata*.

**Proboscidactyla "minima" Browne.**

*Proboscidactyla minima*, Browne, 1905, Pearl Oyster Fisheries, Gulf of Manaar, Suppl. Report, Roy. Soc. London, 27, p. 136, plate 2, fig. 3.

Bell hemispherical (?), 0.75 to 1 mm. wide, with fairly thin walls. 4 main radial-canals with lateral branches. Number of lateral branches (?) 10 to 20 short tentacles 0.25 mm. long with globular basal bulbs. Stomach with 4 longitudinal lobes with the gonads upon their sides. Mouth with a sinuous margin. Clusters of nematocysts on the exumbrella near the

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## Plate 21.

Fig. 1. *Proboscidactyla ornata* var. *gemmifera*, showing a budding medusa about to be set free. Tortugas, Florida, June, 1897.

Fig. 2. *Proboscidactyla ornata* var. *gemmifera*, showing unusually dark pigment in the tentacle-bulbs. Beaufort, North Carolina, November 21, 1904.

Fig. 3. *Proboscidactyla ornata* var. *gemmifera*, showing small immature medusa buds at the 4 radial angles of the stomach. Tortugas, Florida, June 12, 1897.

Fig. 4. *Laodicea cruciata* ("*calcarata*"), young medusa. Agassiz Laboratory, Newport, Rhode Island.

Fig. 5. *Laodicea cruciata* ("*calcarata*"), half-grown male medusa. Agassiz Laboratory, Newport, Rhode Island, September 17, 1896.

Drawn from life, by the author.

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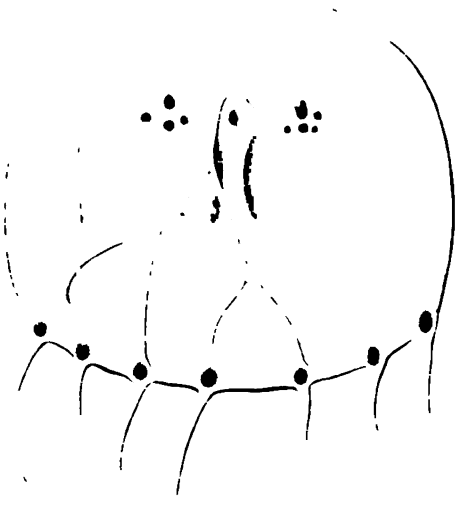

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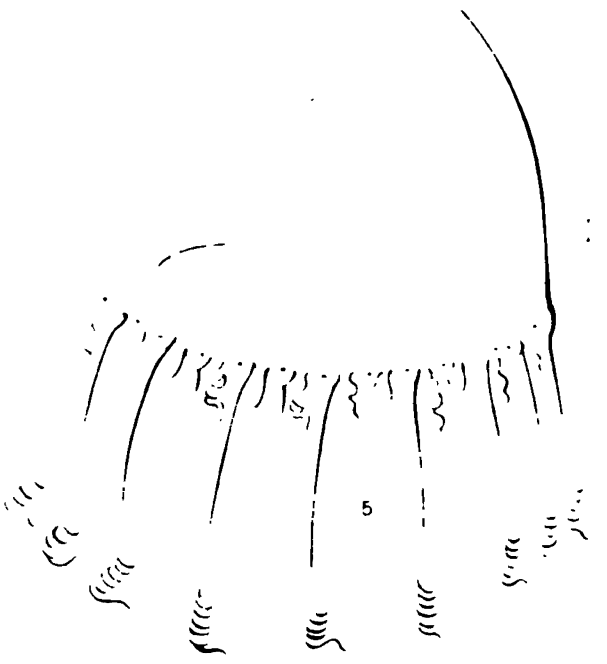

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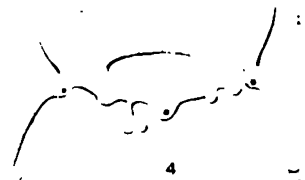

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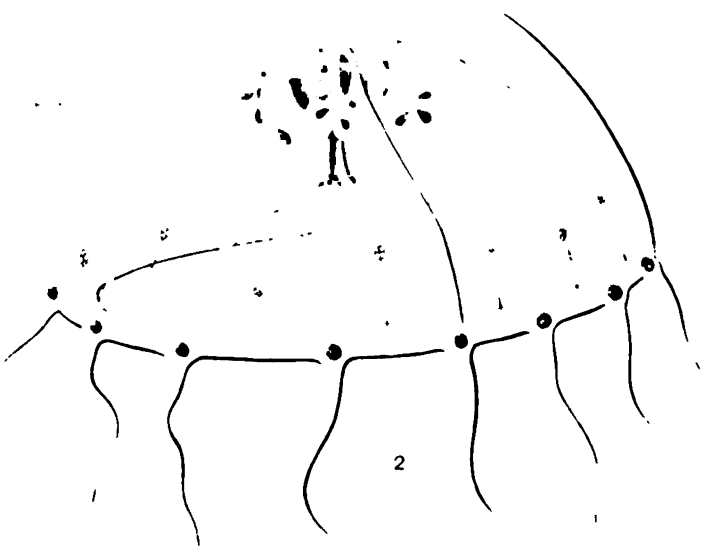

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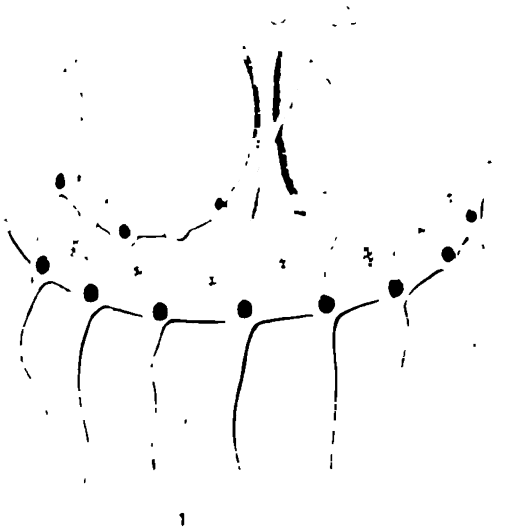

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margin between the tentacles. Gulf of Manaar, near Ceylon, in February. Color (?) Distinguished by its small size (when mature?).

**Proboscidactyla "occidentalis" Browne.**

*Willia occidentalis*, Fewkes, 1889, Bull. Essex Inst., Salem, vol. 21, No. 7, p. 109, plate 5, fig. 3.
*Proboscidactyla occidentalis*, Browne, 1904, Fauna and Geog. Maldive and Laccadive Archipelagoes, vol. 2, p. 726.

Size (?) Bell pyriform, gelatinous substance thick. 4 main radial-canals, each of which gives rise to 2 side branches, which also branch; thus each main radial-canal reaches the margin by 5 vessels. 20 tentacles with reddish basal bulbs. Gonads on the marginal sides of the stomach. 4 lips. A single cluster of nematocyst-cells on the exumbrella between each successive pair of tentacles. Island of Santa Cruz, California. Color (?) Is this only a young stage of *P. flavicirrata*?

**Genus WILLSIA Forbes, 1846.**

*Willsia*, Forbes, 1846, Ann. and Mag. Nat. Hist., ser. 1, vol. 18, p. 268; 1848, British Naked-eyed Medusæ, p. 19. Gosse, 1853, Naturalist's Rambles Devonshire Coast, p. 359.
*Willia*, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 346.
*Willsia*, Peach, 1867, Journ. Roy. Institute, Cornwall, p. 357.
*Willia*, Haeckel, 1879, Syst. der Medusen, p. 158.—Browne, 1902, Annals Mag. Nat. Hist., ser. 7, vol. 9, p. 280; 1904, Hydromedusæ Maldive Islands, p. 729.—Maas, 1904, Sitzungsber. math.-phys. Klasse kgl. Bayer. Akad. der Wissenschaft., Bd. 34, p. 439.

GENERIC CHARACTERS.

Williadi with 6 or more primary radial-canals, each of which gives rise to one or more side branches all of which extend to the bell-margin.

The type species is *Willsia stellata* Forbes, of the northern coast of Europe. Its hydroid stock is *Lar sabellarum* Gosse.

**Willsia stellata Forbes.**

*Willsia stellata*, Forbes, 1846, Annals and Mag. Nat. Hist., ser. 1, vol. 18, p. 268; 1848, British Naked-eyed Medusæ, p. 19, plate 1, fig. 1.—Bedot, 1905, Revue Suisse de Zool., tome 13, p. 152 (literature to 1850). Browne, 1904, Fauna and Geog. Maldive and Laccadive Archipelagoes, vol. 2, p. 729.
*Willia stellata*, Haeckel, 1879, Syst. der Medusen, p. 158.
*Lar sabellarum* (hydroid), Gosse, 1857, Trans. Linnean Soc. London, vol. 22, p. 113, plate 20.
*Lar sabellarum*, Hincks, 1872, Annals and Mag. Nat. Hist., ser. 4, vol. 10, p. 313, plate 19.
(?) *Willia furcata*, Haeckel, *Ibid.*, p. 158.
*Willsia stellata*, Forbes = *Lar sabellarum* Gosse, Browne, 1896, Proc. Zool. Soc. London, p. 468; 1897, Proc. Zool. Soc. London, p. 818, 9 figs. (the best modern description).
*Lar sabellarum*, Browne, 1905, Proc. Roy. Soc. Edinburgh, vol. 25, p. 753 (medusa only).

Bell dome-like, about 9 mm. wide and 8 mm. high, with thick gelatinous walls, evenly rounded. Stomach 6-sided, with well-developed, lateral lobes upon the sides of which the gonads are situated.

When the medusa is set free from the hydroid there are 6 straight, simple radial-canals, 60° apart, but when about 1 mm. wide a side branch grows out from each of the 6 original canals. These side branches grow out from near the middle points of the original canals, and the original canals then bend so that 12 vessels reach the bell-margin nearly 30° apart. In the next stage another side branch arises, farther out than the first and on the opposite side from each of the 6 original canals, and finally a third branch grows out from the inner side of the first branch. Thus each of the 6 original radial-canals gives rise to 3 branches, and hence 24 terminal canals reach the bell-margin. Owing to the bending of the radial-canals the terminal branches are spaced with a fair degree of symmetry, but the intervals between the ends are not constantly 15°, for the space between the main canal and the last-formed branch is apt to remain wider than the other intervals. (See Browne 1905.)

There are 24 short tentacles, one at the end of each terminal branch of the radial-canals. These tentacles have well-developed, basal bulbs and are tapering and shorter than the bell-diameter. 24 short, blindly-ending, centripetal canals extend upward from bell-margin under the surface of the exumbrella, alternating with the tentacles; and there is a cluster of nematocysts upon the exumbrella over each one of these centripetal vessels. There is no ring-canal.

The 6-sided stomach is short, not being longer than one-half to two-thirds the depth of the bell-cavity and there are 6 simple recurved lips. The stomach differs from the Amer-

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ican *Willsia* discovered by Professor Brooks, in being 6-rayed at its center, whereas the center of the stomach of the American medusa is only 3-rayed.

The stomach and gonads are yellow to reddish-yellow and the tentacle-bulbs are dark yellowish-brown or purple-brown. This medusa is found off the coasts of Great Britain and Ireland. It is abundant at Valencia Island off the southern coast of Ireland.

A summary of its stages in growth may be presented thus:

| | Radial-canals. | Tentacles. | Exumbrella clusters of nematocysts. |
|---|---|---|---|
| Earliest stage. | 6 unbranched. | 6 | 6 |
| Second stage. | 1 side branch to each canal. | 12 | 12 |
| Third stage. | 2 opposite branches to each canal. | 18 | 18 |
| Fourth and adult stage. | The first-formed side branch branches. Thus each main canal gives off 3 branches. | 24 | 24 |

The hydroid is "*Lar sabellarum*" of Gosse and Hincks. It grows upon the tube of *Sabella*. The polypites arise at intervals from a creeping hydrorhiza. The fusiform feeding polypites are larger than the reproductive ones and have each 2 tentacles which both arise from one side of the body. The reproductive polypites have no tentacles and their free upper ends are somewhat globular and devoid of a mouth, although they are armed with many nematocysts. The medusa-buds arise in clusters of 3 to 4 on the upper sides of the body of the polypite. When set free the bell is somewhat higher than a hemisphere and the medusa has 6 radial-canals and 6 tentacles alternating with 6 clusters of nematocysts upon the exumbrella. The stomach is 6-lobed and has 6 lips.

Haeckel, 1879, p. 158, describes a "*Willia furcata*" from St. Nazaire, Atlantic coast of France. This may be identical with *W. stellata*, but it is said to have the gonads isolated upon the radial-canals. The lower edge of the stomach is said to be folded or crinkled and without true lips. In other respects the medusa is evidently identical with *W. stellata*. I suspect this of being merely a specimen of *W. stellata* in which the central part of the stomach has been lost through accident and is in process of regeneration.

### Willsia (?) varians.

*Proboscidactyla varians*, BROWNE, 1902, Fauna and Geography Maldive and Laccadive Archipelagoes, vol. 2, p. 728, plate 54, figs. 1, 2.

Browne describes this medusa from a single specimen with an irregular, 6-lobed stomach.

The medusa was 3 mm. wide, 2 mm. high. 6 main radial-canals, each with 1 to 3 lateral branches. 17 tentacles, one at the end of each terminal branch of the radial-canals. No ring-canal. Clusters of nematocysts on the exumbrella. Stomach very irregular with 5 (?) lips. No gonads, but with 2 medusa-buds upon 2 of the radial-canals near the stomach. Tentacle-bulbs dark brown. Maldive Islands, Indian Ocean. This may be an abnormal specimen of *Proboscidactyla ornata var. stolonifera*.

### Willsia mutabilis Browne.

*Willia mutabilis*, BROWNE, 1902, Annals and Mag. Nat. Hist., ser. 7, vol. 9, p. 280; 1904, Fauna and Geog. Maldive and Laccadive Archipelagoes, vol. 2, p. 729.

Bell slightly conical, 6 mm. high and 6 mm. wide. Margin of bell slightly inverted and summit broad and round. There are 24 or more tentacles. 6 or 8 radial-canals arise from the stomach and each gives rise to 3 or more branches. The stomach is small, with 6 or 8 lobes, and the margin of the mouth is complexly folded. The gonads surround the stomach and its lobes. This species is very variable. Found by Vallentine at Stanley Harbor, Falkland Islands and briefly described by Browne. Color (?)

### Willsia brooksii, sp. nov.

Beautiful drawings of a young stage and also of the adult condition of this medusa were made by the late Prof. William K. Brooks, while he was at Beaufort, North Carolina, and were found among his unpublished figures, after his death. They were kindly pre-

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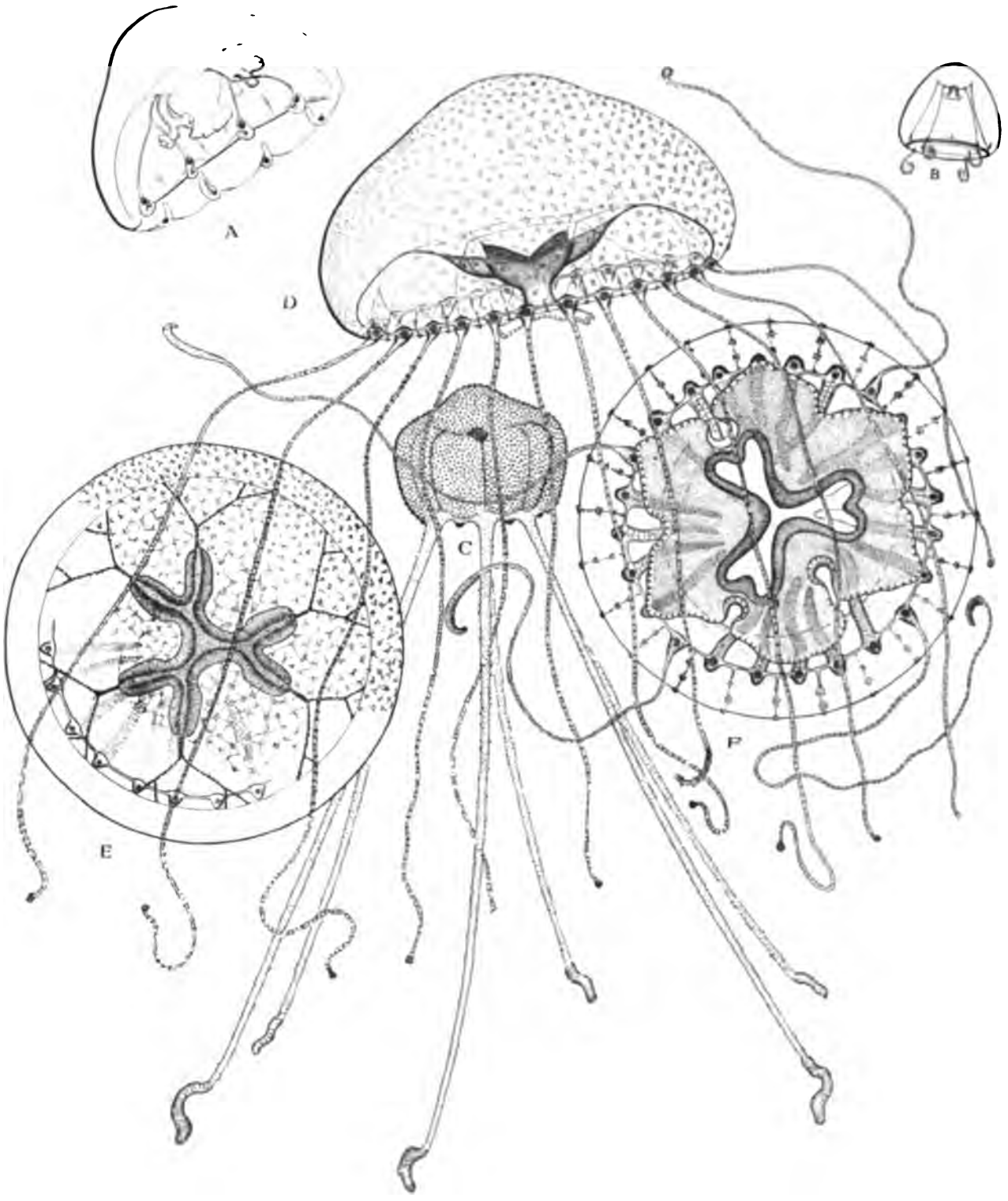


FIG. 101a *A* and *B*, *Proboscidactyla ornata*, var. *gemmifera* showing a young stage with stolons bearing medusa buds C to F, young and mature stage of *Willsia brooksii* sp. nov.; having 6 primary radial-canals, 24 terminal tentacles. From Beaufort, North Carolina. Drawn from life, by Professor Brooks.

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sented to me by the Department of Biology of Johns Hopkins University for publication in this work, and it seems but fitting that the species should be named in honor of the great naturalist who discovered it. It is closely allied and possibly identical with the European *Willsia stellata*, although the 3-rayed center of the stomach appears to distinguish it.

In the young stage there are 6 simple, slender radial-canals, 60° apart. The bell-walls are relatively thin and the bell somewhat higher than a hemisphere with a bluntly pointed apex. The 6 tentacles are 5 to 6 times as long as the bell-diameter and have swollen, nematocyst-bearing, outer extremities.

In the mature medusa the bell is flatter than a hemisphere, thick walled, with a shallow bell-cavity. Twenty-four tentacles alternate with 24 exumbrella, nematocyst tracts each with several clusters of nettling cells. The manubrium has 6 lips. Stomach 3-rayed at center, but each ray forks, giving 6 ramuli, 6 primary radial-canals which bifurcate twice giving 24 terminal branches. The gonads extend along the sides of the stomach. The size and color can not be determined from Professor Brooks's drawings. Found at Beaufort, North Carolina. (See page 195.)

## Order LEPTOMEDUSÆ Haeckel, 1866.

*Leptomedusæ*, HAECKEL, 1866, Generellen Morphologie, Bd. 2, p. lvii; 1879, Syst. der Medusen, p. 111.—BIGELOW, 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 147.—TORREY, 1909, Publications University California, Zool., vol. 6, p. 12.

### CHARACTERS OF THE ORDER LEPTOMEDUSÆ.

Hydromedusæ which arise by alternation of generations from Campanularian hydroids. The gonads are developed upon the radial-canals. When present the lithocysts are of ectodermal origin.

We may distinguish three families as follows:

1. Thaumantiadæ Gegenbaur, 1856. Without lithocysts, but with marginal sensory-clubs or cordyli.
2. Eucopidæ Gegenbaur, 1856. With lithocysts and with less than 8 radial-canals.
3. Æquoridæ Eschscholtz, 1829. With lithocysts and with more than 8 radial-canals.

The Leptomedusæ are probably descended from the more simply organized Anthomedusæ; this is shown by the fact that when first set free from the hydroid some of the Eucopidæ, such as *Phortis*, lack lithocysts, which develop later. Also the hydroid of *Eutina* called *Campanopsis* has nearly all of the characters of the Tubularian hydroids. Asexual production of medusa-buds is extremely rare in the medusæ of the order Leptomedusæ being known only in *Eucheilota paradoxica* and *Eirene medusifera*. These medusæ are therefore creatures of the coasts and are rarely found far out at sea, for they can not maintain themselves in situations unsuited to the growth of their hydroids.

## Family THAUMANTIADÆ Gegenbaur, 1856.

*Thaumantiadæ*, GEGENBAUR, 1856, Zeit. für wissen. Zool., Bd. 8, pp. 218, 236, 268.—MAAS, 1893, Ergeb. der Plankton Exped., Bd. 2, K. c., pp. 64–65; 1897, Mem. Mus. Comp. Zool. at Harvard College., vol. 23, No. 1, p. 19; 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 23.
*Thaumantiadæ + Cannotidæ*, HAECKEL, 1879, Syst. der Medusen, pp. 120, 140.

### FAMILY CHARACTERS.

Leptomedusæ without lithocysts. The gonads are developed upon or extend outward over the radial-canals and are not confined exclusively within the walls of the stomach.

In so far as is at present known the Thaumantiadæ develop through alternation of generations from Campanularian hydroids. For our knowledge of the development of the species constituting this family we are indebted to the researches of Wright, 1862, on *Thaumantias;* A. Agassiz, 1865, on *Melicertum;* Metschnikoff, 1886, on *Laodicea;* and Browne, 1900, on *Dipleurosoma*.

It is evident, indeed, that the Thaumantiadæ are very closely related to the Eucopidæ. They resemble the Tubularian medusæ (Anthomedusæ), however, in the absence of lithocysts and the prevalence of ectodermal ocelli upon the tentacle-bulbs. Indeed, all authorities agree in considering the Thaumantiadæ as more lowly organized than the Eucopidæ and Æquoridæ,

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and probably nearly related to the forms from which the Campanularian medusæ have developed (see A. Agassiz, 1865, pp. 124, 125; O. and R. Hertwig, 1897, Nervensyst. und Sinnesorgane der Medusen, p. 155; Haeckel, 1879, pp. 121, 125; Brooks, 1895, pp. 301–303). Haeckel goes so far as to state that the medusæ of his genus *Tetranema* (*Thaumantias*) are the primitive forms from which the Campanularian medusæ (Leptomedusæ) have been developed!

Asexual budding of medusæ upon the gonads is unknown in the Thaumantiadæ.

Brooks, 1895, shows that the marginal sense-clubs of *Laodicea* contain no trace of concretions. Their cores are entodermal and they arise from the level of the exumbrella nerve-ring, above the velum, and are identical in all their anatomical relations with the sense-clubs of the Narcomedusæ and Trachymedusæ.

Haeckel, 1879, includes *Gonionemus* and the Williadi among the Thaumantiadæ. *Gonionemus* is certainly not one of the Thaumantiadæ, for it has marginal lithocysts; and according to the researches of Hincks, 1872, and Browne, 1896, the Williadi are derived from Tubularian hydroids and should be placed among the Anthomedusæ.

The Thaumantiadæ may be conveniently, although somewhat artificially divided into three subfamilies:

1. Melicertinæ, with simple, unbranched radial-canals.
2. Polyorchinæ, in which the radial-canals give rise to blindly-ending side branches, and these side branches do not fuse with the circular vessel.
3. Berenicinæ, in which the radial-canals give rise to side branches, and these side branches connect with the circular vessel.

A description of the genera of the Thaumantiadæ follows:

Subfamily Melicertinæ: With simple, unbranched radial-canals upon which the gonads are developed. The lips are as numerous as the radial-canals. Ocelli, marginal sense-clubs, cordyli, and cirri are often present. There are no oral tentacles.

*Thaumantias* Eschscholtz, 1829 = *Tetranema* + *Thaumantias* Haeckel, 1879. 4 or more tentacles, 4 radial-canals, and 4 simple lips. No marginal clubs or cirri. Hydroid: *Thaumantias*.

*Laodicea* Lesson, 1843 = *Octonema* + *Laodice* Haeckel, 1879. 4 or more tentacles, with marginal clubs or cirri or both between tentacles. 4 radial-canals, 4 simple lips. Hydroid: *Cuspidella*.

*Melicertum* Oken, *sensu* Agassiz = *Melicertella* + *Melicertum* Haeckel, 1879. With 8 or more tentacles. 8 radial-canals, 8 simple lips, and without marginal sense-clubs and cirri. Hydroid: *Melicertum*.

*Melicertissa* Haeckel, 1879. With 8 or more tentacles. 8 radial-canals and 8 lips. With marginal sense-clubs or cirri. This is equivalent to *Melicertissa* + *Melicertidium* Haeckel, 1879, p. 124.

*Orchistoma* Haeckel, 1879. More than 8 radial-canals and the same number of lips. With or without marginal sense-clubs and cirri. Development unknown.

*Timoides* Bigelow, 1904. 4 radial-canals. Ring-canal gives rise to blindly-ending, centripetal canals. Stomach upon a peduncle. 4 gonads on the radial-canals. Numerous tentacles and cirri. Development unknown.

Subfamily Polyorchinæ: 4 or more radial-canals which give rise to blindly-ending side branches that do not reach the circular vessel. Gonads upon radial-canals, or upon their side branches. Ocelli, marginal sense-clubs, and cirri are often present.

*Staurodiscus* Haeckel, 1879. 4 radial-canals, each of which gives rise to 2 blindly-ending side branches. Gonads upon 4 main radial-canals, also upon side branches. There are marginal sense-clubs. Manubrium tubular, with 4 simple lips. Development unknown.

*Ptychogena* A. Agassiz, 1865. 4 radial-canals, which give rise to numerous blindly-ending side branches upon which gonads are developed. Manubrium wide and shallow. Mouth simple, large, cruciform opening. Development unknown.

*Polyorchis* A. Agassiz, 1862–65. 4 radial-canals, which give rise to many blindly-ending side branches. A number of free sack-shaped gonads arise from radial-canals. Bell-margin simple. Manubrium long and tubular, and there are 4 simple lips. The ring-canal is simple without centripetal branches.

*Scrippsia*, Torrey, 1909. Similar to *Polyorchis*, but with a gastric peduncle and without pinnate branches on the radial-canals distal to the gonads. (See Appendix.)

*Spirocodon* Haeckel, 1879 = *Goneomeandrus* Kirkpatrick, 1903. Similar to *Polyorchis*, but ring-canal gives rise to blindly-ending centripetal branches and bell-margin divided into lappets. Development unknown.

Subfamily Berenicinæ: Radial-canals branch and all branches connect with circular vessel. Lips as numerous as main radial-canals. Ocelli, marginal clubs, and cirri often present.

*Cannota* Haeckel, 1879. 4 main radial-canals each of which gives rise to 2 simple side branches, and thus 12 canals connect with the circular vessel. There are 12 gonads, 1 upon each terminal branch of the radial-canals.

*Cuvieria* Péron, 1807 = *Berenice* Haeckel, 1879. The 4 main radial-canals give rise to non-dichotomous side branches, and the side branches also branch. Gonads on the terminal branches of the radial-canals.

*Dichotomia* Brooks, 1903. 4 main radial-canals all of which divide dichotomously two or more times. The gonads extend outward from the sides of the stomach over the radial-canals and their branches.

*Dipleurosoma* Axel Borck, 1866 = *Tetracannota* Mayer, 1900. 3 or more main radial-canals, some or all of which give rise to non-dichotomous branches. Gonads on the canals adjacent to the manubrium. According to Browne, the hydroid appears to be *Cuspidella*?

*Tovorchis sens. emend.*, Haeckel = *Tovorchis* + *Cladocanna* Haeckel, 1879. 4 or more main radial-canals which branch dichotomously one or more times. The gonads are upon the outer branches of the radial-canals near the circular canal.

*Netocertoides* Mayer, 1900. 8 main radial-canals, which branch dichotomously. The gonads extend outward from the sides of the stomach along the radial-canals.

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## Plate 21.

Fig. 1. *Proboscidactyla ornata* var. *gemmifera*, showing a budding medusa about to be set free. Tortugas, Florida, June, 1897.

Fig. 2. *Proboscidactyla ornata* var. *gemmifera*, showing unusually dark pigment in the tentacle-bulbs. Beaufort, North Carolina, November 21, 1904.

Fig. 3. *Proboscidactyla ornata* var. *gemmifera*, showing small immature medusa buds at the 4 radial angles of the stomach. Tortugas, Florida, June 12, 1897.

Fig. 4. *Laodicea cruciata* ("*calcarata*"), young medusa. Agassiz Laboratory, Newport, Rhode Island.

Fig. 5. *Laodicea cruciata* ("*calcarata*"), half-grown male medusa. Agassiz Laboratory, Newport, Rhode Island, September 17, 1896.

Drawn from life, by the author.

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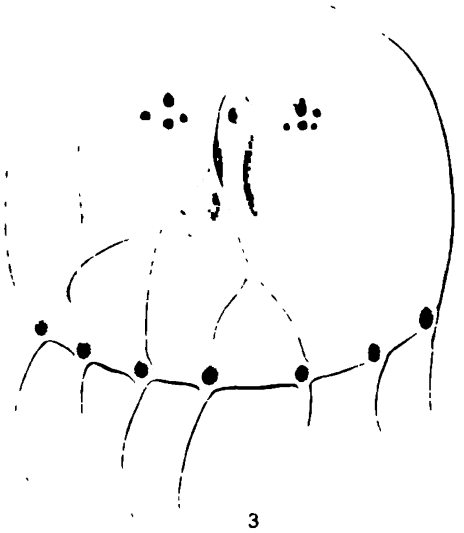

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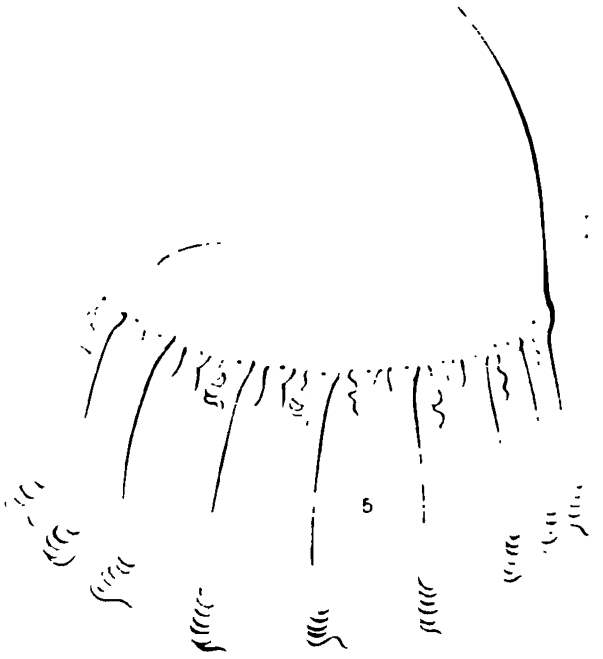

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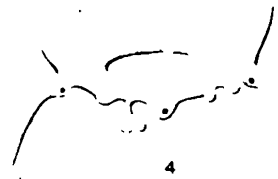

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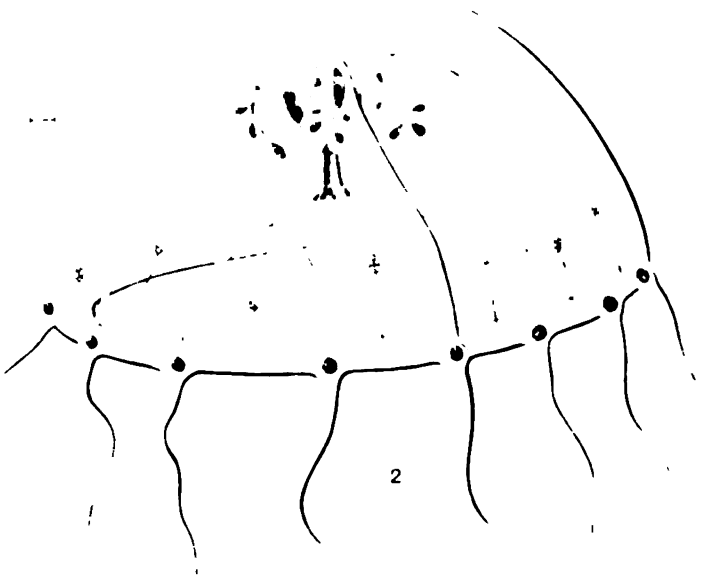

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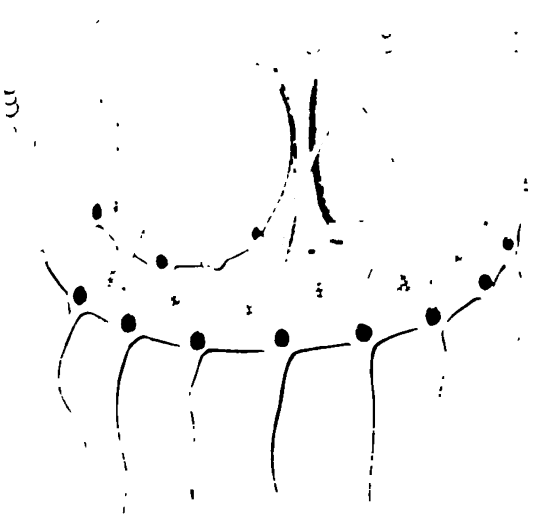

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margin between the tentacles. Gulf of Manaar, near Ceylon, in February. Color (?) Distinguished by its small size (when mature?).

**Proboscidactyla "occidentalis" Browne.**

*Willia occidentalis*, Fewkes, 1889, Bull. Essex Inst., Salem, vol. 21, No. 7, p. 109, plate 5, fig. 3.
*Proboscidactyla occidentalis*, Browne, 1904, Fauna and Geog. Maldive and Laccadive Archipelagoes, vol. 2, p. 726.

Size (?) Bell pyriform, gelatinous substance thick. 4 main radial-canals, each of which gives rise to 2 side branches, which also branch; thus each main radial-canal reaches the margin by 5 vessels. 20 tentacles with reddish basal bulbs. Gonads on the marginal sides of the stomach. 4 lips. A single cluster of nematocyst-cells on the exumbrella between each successive pair of tentacles. Island of Santa Cruz, California. Color (?) Is this only a young stage of *P. flavicirrata*?

## Genus WILLSIA Forbes, 1846.

*Willsia*, Forbes, 1846, Ann. and Mag. Nat. Hist., ser. 1, vol. 18, p. 268; 1848, British Naked-eyed Medusæ, p. 19. Gosse, 1853, Naturalist's Rambles Devonshire Coast, p. 359.
*Willia*, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 346.
*Willsia*, Peach, 1867, Journ. Roy. Institute, Cornwall, p. 357.
*Willia*, Haeckel, 1879, Syst. der Medusen, p. 158.—Browne, 1902, Annals Mag. Nat. Hist., ser. 7, vol. 9, p. 280; 1904, Hydromedusæ Maldive Islands, p. 729. - Maas, 1904, Sitzungsber. math.-phys. Klasse kgl. Bayer. Akad. der Wissenschaft., Bd. 34, p. 439.

### GENERIC CHARACTERS.

Williadi with 6 or more primary radial-canals, each of which gives rise to one or more side branches all of which extend to the bell-margin.

The type species is *Willsia stellata* Forbes, of the northern coast of Europe. Its hydroid stock is *Lar sabellarum* Gosse.

**Willsia stellata Forbes.**

*Willsia stellata*, Forbes, 1846, Annals and Mag. Nat. Hist., ser. 1, vol. 18, p. 268; 1848, British Naked-eyed Medusæ, p. 19, plate 1, fig. 1. - Bedot, 1905, Revue Suisse de Zool., tome 13, p. 152 (literature to 1850). Browne, 1904, Fauna and Geog. Maldive and Laccadive Archipelagoes, vol. 2, p. 729.
*Willia stellata*, Haeckel, 1879, Syst. der Medusen, p. 158.
*Lar sabellarum* (hydroid), Gosse, 1857, Trans. Linnean Soc. London, vol. 22, p. 113, plate 20.
*Lar sabellarum*, Hincks, 1872, Annals and Mag. Nat. Hist., ser. 4, vol. 10, p. 313, plate 19.
(?) *Willia furcata*, Haeckel, *Ibid.*, p. 158.
*Willsia stellata*, Forbes = *Lar sabellarum* Gosse, Browne, 1896, Proc. Zool. Soc. London, p. 468; 1897, Proc. Zool. Soc. London, p. 818, 9 figs. (the best modern description).
*Lar sabellarum*, Browne, 1905, Proc. Roy. Soc. Edinburgh, vol. 25, p. 753 (medusa only).

Bell dome-like, about 9 mm. wide and 8 mm. high, with thick gelatinous walls, evenly rounded. Stomach 6-sided, with well-developed, lateral lobes upon the sides of which the gonads are situated.

When the medusa is set free from the hydroid there are 6 straight, simple radial-canals, 60° apart, but when about 1 mm. wide a side branch grows out from each of the 6 original canals. These side branches grow out from near the middle points of the original canals, and the original canals then bend so that 12 vessels reach the bell-margin nearly 30° apart. In the next stage another side branch arises, farther out than the first and on the opposite side from each of the 6 original canals, and finally a third branch grows out from the inner side of the first branch. Thus each of the 6 original radial-canals gives rise to 3 branches, and hence 24 terminal canals reach the bell-margin. Owing to the bending of the radial-canals the terminal branches are spaced with a fair degree of symmetry, but the intervals between the ends are not constantly 15°, for the space between the main canal and the last-formed branch is apt to remain wider than the other intervals. (See Browne 1905.)

There are 24 short tentacles, one at the end of each terminal branch of the radial-canals. These tentacles have well-developed, basal bulbs and are tapering and shorter than the bell-diameter. 24 short, blindly-ending, centripetal canals extend upward from bell-margin under the surface of the exumbrella, alternating with the tentacles; and there is a cluster of nematocysts upon the exumbrella over each one of these centripetal vessels. There is no ring-canal.

The 6-sided stomach is short, not being longer than one-half to two-thirds the depth of the bell-cavity and there are 6 simple recurved lips. The stomach differs from the Amer-

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## Plate 22.

Fig. 1. *Dissonema turrida*, mature male. Tortugas, Florida, June 21, 1907.

Figs. 2 to 4. *Laodicea cruciata* ("*calcarata*"). Successive stages in the development of the medusa. Agassiz Laboratory, Newport, Rhode Island, June to September, 1892.

Fig. 5. *Laodicea cruciata* ("*calcarata*"). Part of the bell-margin of the medusa shown in figure 4.

Fig. 6. *Laodicea cruciata* ("*calcarata*"). Details of the gonads and manubrium of the medusa shown in figure 4.

Fig. 7. *Staurodiscus tetrastaurus*, young medusa. Charleston Harbor, South Carolina, September 14, 1897.

Fig. 8. *Staurodiscus tetrastaurus*, young medusa. A sense-club from the bell-margin.

See page 116 for description of figure 1.

Drawn from life, by the author.

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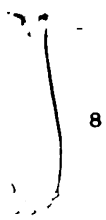

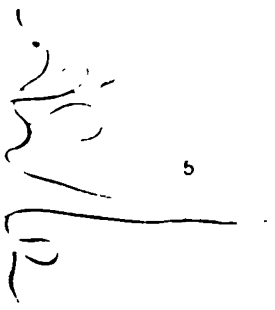

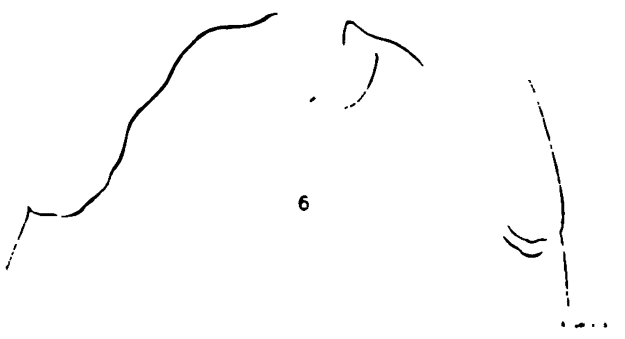


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## Genus LAODICEA Lesson, 1843.

*Laodicea*, Lesson, 1843, Hist Zooph. Acal., p. 294. A. Agassiz in L. Agassiz's, 1862, Cont. Nat. Hist. U. S., vol. 4, p. 350.—Agassiz and Mayer, 1899, Bull. Mus. Comp. Zool. at Harvard College, vol. 32, p. 162. Haeckel, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 43.
*Cosmetira*, Forbes, 1848, British Naked-eyed Medusæ, p. 42.
*Thaumantias*, Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, p. 237.
*Lafœa*, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 351. Agassiz, A., 1865, North Amer. Acal., p. 122.
*Atractylis*, Wright, 1861, Ann. and Mag. Nat. Hist., ser. 3, vol. 8, p. 129.
*Cuspidella* (hydroid), Hincks, 1868, British Hydroid Zooph., p. 209, plate 40.
*Octonema+Laodice*, Haeckel, 1879, Syst. der Medusen, pp. 126, 131.
*Laodice*, Metschnikoff, 1886, Embryol. Studien an Medusen, Wien, p. 23, etc. (development). Brooks, 1895, Journal Morphology, vol. 10, p. 287.- Browne, 1896, Proc. Zool. Soc. London, p. 482; *Ibid.*, 1898, p. 823. -Maas, 1904, Résult. Camp. Sci. Prince de Monaco, Fasc. 28, p. 18; 1905, Die Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 24.—Bedot, 1901, Revue Suisse de Zool., tome 9, p. 483; *Ibid.*, 1905, tome 13, p. 136 (citation of all references to 1850).—Browne, 1907, Annals and Mag. Nat. Hist., vol. 20, ser. 7, p. 459.
*Genus x*, Maas, 1893, Hydromedusen Plankton Expedition, p. 65.
*Octorphalon*, von Lendenfeld, 1884, Proc. Linnean Soc. New South Wales, vol. 9, p. 919.

This genus was founded by Lesson, 1843, for *Laodicea cruciata*, of the coast of Europe, which appears to have been previously described by Forskål, 1775, under the name of *Medusa cruciata*.

### GENERIC CHARACTERS.

Thaumantiadæ with 4 gonads upon the 4 radial-canals. With 4 or more tentacles. The tentacle-bulbs often bear ectodermal ocelli. Sensory-clubs (cordyli) and cirri are situated between the tentacles. The stomach is without a peduncle. There are 4 simple, cruciform lips. The hydroid is *Cuspidella* Hincks.

Brooks, 1895, shows that the sensory-clubs of *Laodicea* are situated upon the ectodermal nerve-ring, which is found on the exumbrella side of the bell immediately above the velum. The core of each sense-club is composed of entodermal cells which are in direct connection with the entoderm of the circular canal. The sense-clubs contain no concretions. Anatomically the sense-clubs of *Laodicea* are strikingly similar to the embryonic sense-clubs of the Narcomedusæ and Trachymedusæ, but they lack concretions. On the other hand there can be no doubt that *Laodicea* is closely related to the lithocyst-bearing Leptomedusæ or Vesiculatæ of the Hertwig brothers.

Haeckel introduced the spelling *Laodice*, but Lesson's original name is spelled *Laodicea*. Our *Laodicea* is equivalent to *Laodice+Octonema* Haeckel. The medusæ of *Laodicea* are extremely variable in color and in the arrangement of their tentacles, cirri, ocelli, and marginal sense-clubs. I am inclined to believe that *L. ulothrix*, *L. calcarata* of the Atlantic, *L. indica* of Ceylon, and *L. marama* of the Fiji Islands are only local races of *L. cruciata* of the Mediterranean and Atlantic coasts of Europe. All of these so-called species are possibly only imperfectly differentiated local races of *Laodicea cruciata*. Browne, 1896, 1898, has shown that the common Mediterranean, European, and American *Laodicea* are probably one and the same species, and my own studies serve only to convince me of the correctness of his view.

As in *Tiaropsis* the species of *Laodicea* fall into two well-defined groups: Those with 4 to 8 tentacles, represented by *L. eucope*, *fertilis*, *neptuna*, and *gelatinosa*, and those with 32 to 300 tentacles, represented by *L. cruciata*, *chapmani*, and *pulchra*.

Metschnikoff, 1886, made elaborate studies of the development of the egg of the *Laodicea cruciata* of the Mediterranean; and he succeeded in rearing the larvæ until they developed into small hydroids of the genus *Cuspidella* Hincks.

### Laodicea cruciata L. Agassiz.

Plate 21, figs. 4 and 5; plate 22, figs. 2 to 6; plate 23, figs. 1 to 3.

*Laodicea calcarata*, A. Agassiz, in L. Agassiz's, 1862, Cont. Nat. Hist. U. S., vol. 4, p. 350. Haeckel, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 43, 1 fig. Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 25.
*Lafœa cornuta*, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 351 (*non L. cornuta*, Lamouroux). Agassiz, A., 1862, Proc. Boston Soc. Nat. Hist., vol. 9, p. 91, fig. 4.
*Campanularia dumosa*, Leidy, 1855, Marine Invert. Fauna of R. I. and N. J., p. 6.
*Lafœa calcarata*, Agassiz, A., 1865, North Amer. Acal., p. 122, figs. 184, 194.
*Laodice calcarata*, Haeckel, 1879, Syst. der Medusen, p. 134. Brooks, 1895, Journal of Morphology, vol. 10, p. 287, plate 17, figs. 5–7. Browne, 1895, Trans. Liverpool Biol. Soc., vol. 9, p. 276; 1898, Proc. Zool. Soc. London for 1897, p. 833, plate 49, fig. 4; 1900, Proc. Royal Irish Acad. Dublin, ser. 3, vol. 5, p. 720.
*Lafœa calcarata*, Verrill, 1873, Report Commiss. Fish and Fisheries for 1871–72, p. 529.

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*Hebella calcarata* (hydroid and medusa), NUTTING, 1901, Bull. U. S. Fish Commission for 1899, pp. 353, 378, figs. 56, 94.
*Laodice indica*, BROWNE, 1905, Pearl Oyster Fisheries Gulf of Manaar, Suppl. Report 27, Roy. Soc. London, p. 136, plate 1, fig. 5; plate 4, figs. 7–11 (Ceylon).
*Laodice ulothrix*, HAECKEL, 1879, Syst. der Medusen, p. 133, taf. 8, fign. 5–7.—BROOKS, 1895, Amer. Journal Morphology, vol. 10, p. 304, plate 17, 7 figs.
*Laodicea ulothrix*, MAYER, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 49; 1904, Mem. Nat. Sci. Brooklyn Institute Museum, vol. 1, p. 14, fig. 30, plate 4.
*Laodicea marama*, AGASSIZ, A., and MAYER, 1899, Bull. Mus. Comp. Zool. at Harvard College., vol. 32, p. 162, plate 3, figs. 7, 8 (Fiji Islands).
(?) *Medusa æquorea*, BASTER, 1759, Opuscula subseciva, II, p. 55, taf. 5, fign. 2, 3.
(?) *Medusa cruciata*, FORSKÅL, 1775, Descript. anim., p. 110, taf. 33, fig. A.
*Thaumantias undulata*, FORBES and GOODSIR, 1853, Trans. Roy. Soc. Edinburgh, vol. 20, p. 313, plate 10, fig. 7.
*Thaumantias mediterranea*, GEGENBAUR, 1856, Zeit. für wissen. Zool., Bd. 8, p. 237, taf. 8, fign. 1–3.
*Laodice cruciata*, AGASSIZ, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 350.—HAECKEL, 1879, Syst. der Medusen, p. 132 (a list of bibliography).—BROWNE, 1896, Proc. Zool. Soc. London, p. 483 (a good discussion of the literature).—GRAEFFE, 1884, Arbeit. Zool. Inst. Wien, Bd. 5, p. 357.—METSCHNIKOFF, E., 1886, Embryologische Studien an Medusen, Wien, pp. 23 (egg), 37 (segmentation), 57 (formation of entoderm), 83 (polypite), taf. 4, fign. 17–31; taf. 5, fig. 1.
(?) *Laodice pulchra*, BROWNE, 1902, Annals and Mag. Nat. Hist., ser. 7, vol. 9, p. 280 (Falkland Islands).
*Laodicea cruciata* L. AG. = *Thaumantias mediterranea* GEGENEAUR; METSCHNIKOFF, E., 1886, Arbeit. Zool. Inst. Wien, Bd. 6, p. 239.
*Cosmetira salinarum*, DU PLESSIS, 1879, Annal. Mag. Nat. Hist., London, vol. 3, p. 385 (= *L. cruciata*).
*Laodice salinarum*, HAECKEL, 1879, Syst. der Medusen, p. 636 (from the salt ditches of Montpellier, Mediterranean coast of France).
*Laodice cruciata*, BEDOT, 1901, Revue Suisse de Zool., tome 9, p. 483; *Ibid.*, 1905, tome 13, p. 136 (all papers cited to 1850).
*Hebella calcarata*, THORNELY, 1905, Report Pearl Oyster Fisheries of Ceylon, Roy. Soc. London, Part 2, p. 116 (hydroid from the Gulf of Manaar, Ceylon).
*Laodice calcarata, etc.*, BROWNE, 1907, Annals and Mag. Nat. Hist., vol. 20, ser. 7, p. 460; *Cuspidella* (hydroid), *Ibid.*, p. 463.

It is difficult to determine the correct name of this medusa. *Medusa cruciata* Forskål, 1775, is so vaguely described and figured that it will never be possible to determine its true relationships, and this is also true of *Medusa æquorea* Baster, 1759.

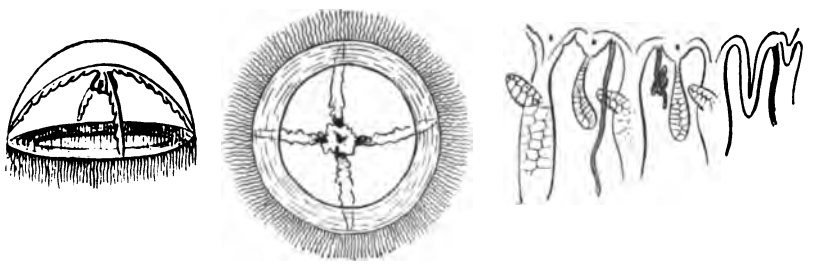

FIG. 104.—*Laodicea "mediterranea,"* after Gegenbaur, in Zeit. für wissen. Zool., Bd. 8.
Oral and side views of medusa and part of bell-margin showing tentacular spurs.

*Thaumantias mediterranea* Gegenbaur, 1856, is evidently a *Laodicea*, and is the same medusa which L. Agassiz, 1862, and Haeckel, 1879, call *Laodice cruciata*. Browne, 1896, 1898, inclines to the opinion that *L. calcarata*, *L. ulothrix* and *Thaumantias mediterranea* = *L. cruciata* L. Agassiz and Haeckel, and are one and the same species. My studies of *Laodicea "calcarata,"* which is very abundant along the Atlantic coast of the United States south of Cape Cod, has convinced me that it is identical with *Laodicea cruciata* of Europe, and is also distributed widely over the Pacific, where it has been called *L. marama* and *L. indica*. The extreme variability in color and in the development of the marginal appendages has caused much confusion in the naming of this most abundant and widely spread medusa. The old name *L. cruciata* takes precedence over *"calcarata"* and should supersede it, being, indeed, synonymous with it, but nevertheless the identity between this medusa and *"Medusa cruciata"* of Forskål must remain in doubt. It seems advisable, however, to retain an old and familiar name rather than to reinstate an unfamiliar one such as *L. undulata*, which is the specific name given to this medusa by Forbes and Goodsir, 1853.

*Adult medusa* (plate 22, fig. 4).—The bell is about 20 to 25 mm. in diameter, and when fully expanded it is somewhat flatter than a hemisphere. Being very flexible, however, it assumes all sorts of distorted forms under the influence of contraction. The gelatinous substance is not thick at the apex and becomes regularly thinner toward the margin. There are 70 to 150, or more, long tentacles, the ends of which are usually coiled in a close helix, while the main shaft of each tentacle is quite straight and rigid. The basal bulbs of the tentacles are large and hollow and often have abaxial spur-like projections; and there is a dark-brown or

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## Plate 23.

Figs. 1 and 2. *Laodicea cruciata* var. *ulothrix*. Successive stages in the development of the medusa, Tortugas, Florida, June, 1897.

Fig. 3. *Laodicea cruciata* var. *ulothrix*. Oral view of gonads of a female medusa. Nassau Harbor, Bahamas, June, 1903.

Fig. 4. *Melicertum campanula*, young medusa. Nahant, Massachusetts, May 6, 1898.

Fig. 5. *Melicertum campanula*, mature male. Marblehead, Massachusetts, July 6, 1900.

Drawn from life, by the author.

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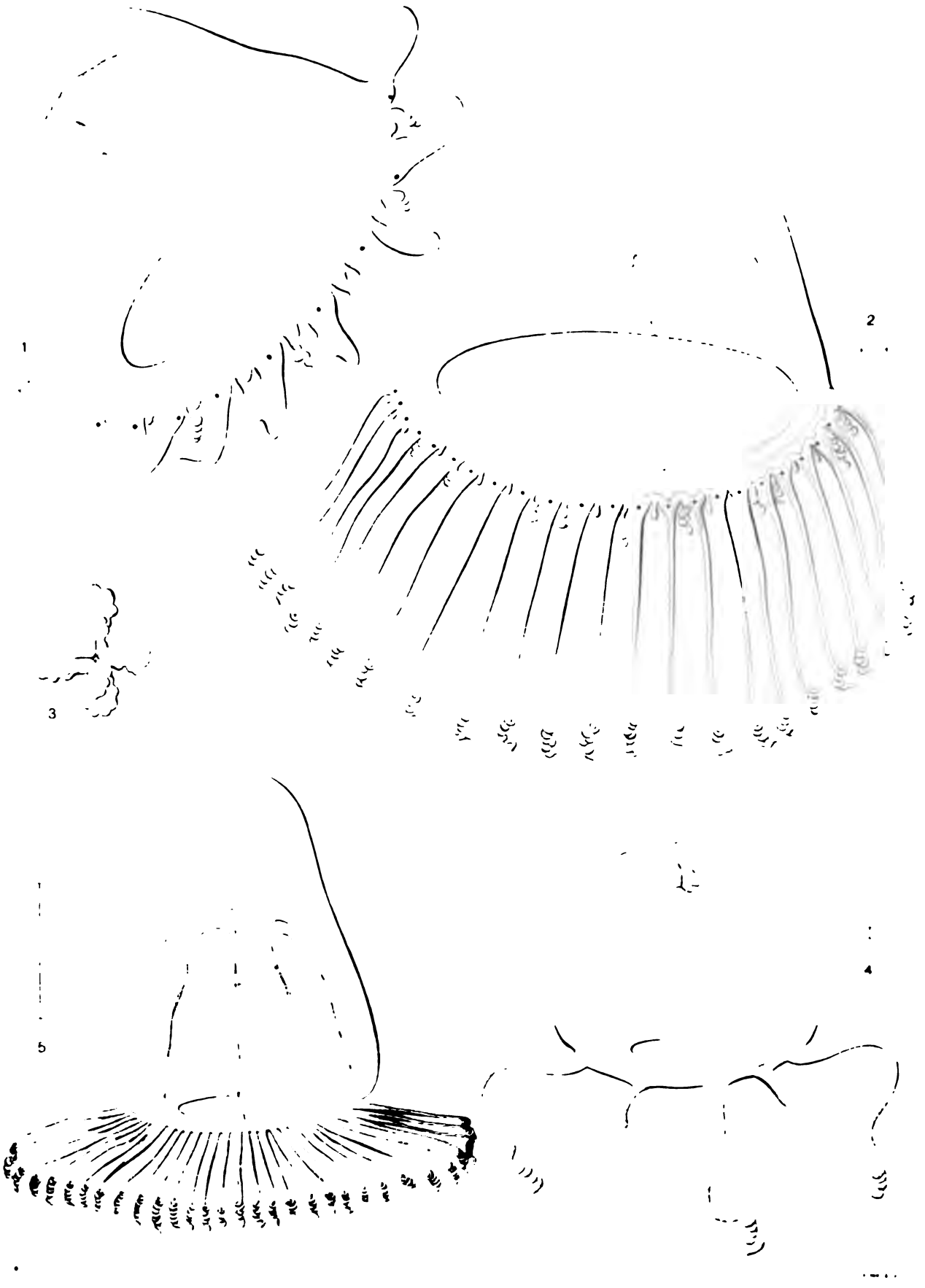


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purple ocellus situated within the ectoderm of the inner (centripetal) side of most of the tentacle-bulbs. There are a number of coiled cirri scattered between the tentacle-bulbs (plate 22, fig. 5). These are usually somewhat less numerous than the tentacles. They arise at a short distance above the bell-margin on the exumbrella side of the bell. The core of each cirrus is made up of highly vacuolated entoderm-cells which are continuous with the entoderm of the circular canal.

Numbers of spindle-shaped nematocyst-capsules are found in the ectoderm at the distal end of each cirrus. In addition to the cirri there are one or two clubs, or cordyli, between each successive pair of tentacles. The distribution of these cordyli is very irregular, but they are usually somewhat more numerous than the tentacles. Each club is flask-shaped and united to the bell-margin by means of a narrow neck. They arise from the side of the exumbrella at the level of the upper nerve-ring, a very short distance above the level of the velum. The core of each sense-club is composed of large, highly vacuolated, entodermal cells which are directly continuous with the entoderm of the circular-canal (see Brooks, 1895, plate 17, fig. 5). The

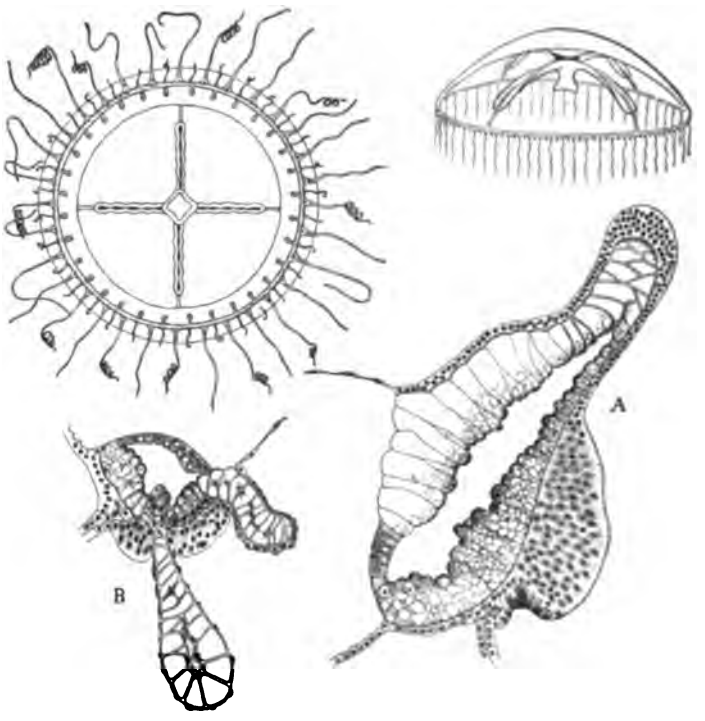


FIG. 105.—*Laodicea cruciata* (*ulothrix*), after Brooks, in Journal of Morphology, vol. 10.
*A*. Section of tentacle. *B*. Section of one of the marginal clubs.

clubs are not solid for there is usually a small intercellular lumen in the axis of the broad distal end of the club. There are no concretions. The velum is well developed. There are 4 straight, narrow radial-canals. The stomach is short and quadrangular in cross-section, and there are 4 recurved, slightly crinkled lips. In fully grown individuals the gonads extend from the sides of the stomach down nearly, if not quite, the entire length of the radial-canals. The medusa is very variable in color, some individuals being nearly colorless. In others the entoderm of the manubrium, gonads, and tentacle-bulbs is green or pink, and the entodermal lamella of the bell is of a delicate green, while in others the entoderm is milky or dull translucent yellow.

This medusa is common along the coast of the United States from June to early winter, along the southern shores of New England to Cuba and the West Indies, but it has not been taken north of Massachusetts Bay. It ranges into more northerly latitudes off the European coast, however, for Browne took it in Valencia Harbor on the southern coast of Ireland. It is seen in the Mediterranean from October to December, and is found in the Fiji Islands,

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and Ceylon, in the Pacific and Indian Oceans. It is common only near coasts, not being a creature of the open ocean. It appears to be far more abundant off the coast of America than in European waters. I found it only occasionally at Naples during the winter of 1907–08.

The development has been studied by Metschnikoff. The early stages are described for the Mediterranean *L. cruciata*. The egg is 0.18 mm. in diameter and is laid between 4 and 5 in the afternoon from November to December. Segmentation is total and equal; and an oval, hen's-egg-shaped, ciliated, one-layered blastula is formed. Sometimes one sees a slight temporary invagination at the narrow hinder end of the blastula, but this is not the beginning of the formation of the entoderm. The entoderm on the contrary is formed from numerous cells which migrate individually into the large central segmentation cavity from the hinder end of the blastula. The resulting planula swims about for a time, but finally it attaches itself and becomes a creeping, root-like, slightly branched hydrorhiza, from which there arise unbranched polypites "resembling *Cuspidella humilis* or *Cuspidella costata* Hincks."

The hydrotheca is long and subcylindrical, and the margin is provided with sharp-pointed teeth, and the polypite may withdraw within the hydrotheca and close the opening by the folding together of these teeth. The polypites have flaring, open, urn-shaped peristomes, below which there is a zone of 10 long, slender, filiform, nematocyst-studded tentacles, all of about the same length.

Browne, 1907, states that Miss M. Delap, of Valencia Island, off the southern coast of Ireland, maintained a colony of *Cuspidella costata* Hincks alive, and obtained from it young medusæ which resemble the youngest stages of *Laodicea calcarata* found in the Ocean. It is probable, therefore, that the hydroid described by A. Agassiz, 1865, as *Lafœa calcarata* and which he believed to be the nurse of *Laodicea* is not such. It lacks the toothed operculum found in *Cuspidella* and the margin of the hydrotheca is simple and entire. The direct embryological evidence demonstrates that the hydroid of *Laodicea* is *Cuspidella* Hincks.

*Tabular Synopsis of the "Varieties" of Laodicea cruciata.*

| | L. cruciata according to Haeckel, 1879 = T. mediterranea Gegenbaur, 1856. | L. calcarata according to my studies. | L. ulothrix, according to Haeckel, Brooks, and Mayer. | L. marama Agassiz and Mayer. | L. indica Browne. |
|---|---|---|---|---|---|
| Shape and diameter of bell in mm. | Flat. 20 to 30 | Flat to hemispherical. 20 to 25 | Flat to hemispherical. 20 | Flat. 5.5 (young). | Flat. 5 to 6 |
| Number of tentacles. | 100 to 120 with ocelli and basal spurs. | 75 to 150 or more. Some with, some without, basal spurs or ocelli. Ocelli very variable in size and number. Spurs sometimes entirely absent. | 70 to 100 as in L. "calcarata." | 50 as in L. calcarata. | 60 to 80 with large ocelli and no basal spurs. |
| Arrangement and character of marginal appendages. | Clubs and cirri more numerous than tentacles and irregularly scattered between them. | Clubs and cirri sometimes more, sometimes less, numerous than tentacles. Sometimes quite regularly arranged, but usually irregularly placed. | As in L. "calcarata." | As in L. "calcarata." | As in L. "calcarata." |
| Character of gonads. | Frilled and developed along entire lengths of the 4 radial-canals so as to touch ring-canal. | More or less frilled. Sometimes mature when only about two-thirds as long as radial-canals; sometimes developed over entire lengths of radial-canals. | As in L. "calcarata." | Immature. Only half as long as radial-canals. | Immature(?). Only half as long as radial-canals. |
| Color. | Very variable. Stomach, gonads, and tentacle-bulbs faint red, purple, blue, brownish, violet, etc. | Very variable, as in L. cruciata. | Variable, but rarely so brilliant as in northern examples. | Blue to green. | (?) |
| Where found. | Mediterranean and Atlantic coasts of Europe. | Atlantic coast of United States. Boston Harbor to West Indies. | Canary Islands, Bahamas, Tortugas. | Fiji Islands, South Pacific. | Ceylon, Indian Ocean. |

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When set free the medusa usually has 2 long tentacles, 2 well-developed basal bulbs, and 4 small interradial swellings upon the bell-margin. At this time the bell is about 1 mm. in height and about 0.7 mm. in diameter (plate 22, fig. 2). Its outer surface is covered with nematocyst-cells. There are only one or two marginal clubs or cirri in the young medusæ. There are, however, well-developed ocelli within the ectoderm of the inner (centripetal) side of each tentacle-bulb. The 4 radial tubes are straight and narrow and the gonads are represented by 4 scarcely perceptible swellings adjacent to the sides of the manubrium. The manubrium is a simple tube with 4 small cruciform lips.

As development proceeds the tentacles increase in number, as do also the clubs and cirri. The bell becomes relatively flatter until it approaches a hemisphere. The gonads begin to develop at the angles of the manubrium and soon grow down the radial-canals until they extend to the circular canal. The manubrium acquires 4 recurved folded lips.

A synopsis of the so-called varieties of *L. cruciata* such as is given on page 204, may be of service in illustrating that we have here only one species.

### Laodicea fijiana Agassiz and Mayer.

*Laodicea fijiana*, Agassiz, A., and Mayer, 1899, Bull. Mus. Comp. Zool. at Harvard College, vol. 32, p. 163, plate 3, figs. 9, 10. *Laodice fijiana* (var. *indica*?), Maas, 1905, Craspedoten Medusen der *Siboga* Exped., Monog. 10, p. 25, taf. 2, figs. 14, 15, taf. 5, figs. 32–35; 1906, Revue Suisse de Zool., tome 14, p. 89. –Browne, 1907, Annals and Mag. Nat. Hist., ser. 7, vol. 20, p. 467; *L. maasi*, p. 466.

Bell 12 to 20 mm. wide, 4 to 5 mm. high. Bell-walls, although thin, quite rigid. 160 tentacles. These are flexible, tapering, with coiled ends, and are about as long as the bell-radius. About half to three-fourths of the tentacles have a dark-brown ectodermal ocellus upon the inner (axial) sides of their basal bulbs. There are a few clubs on the margin between the tentacles; about 12 to 15 in each quadrant in a large medusa, but only about 2 in each quadrant in specimens 6 mm. wide. There are no cirri between the tentacles.

The stomach is square in cross-section, very flat, and without a peduncle. It is about one-fourth as wide as the bell-diameter and the lips are widely open, their folded edges inclosing an open square.

The gonads are developed upon the proximal parts of the 4 radial-canals and grow outward from the angles of the stomach, so that in large medusæ they may extend over two-thirds to seven-eighths of the length of each radial-canal, nearly touching the ring-canal. They are developed upon numerous short side branches of each of the 4 radial-canals, so that they are complexly folded and quite wide. In the female the ova stand out prominently over the surface of the ectoderm. The outer portions of the 4 radial-canals, which lack gonads, are straight and narrow and of the same width as the circular vessel.

The entoderm of the stomach, tentacles, and radial-canals is opaque and milky-blue in color.

Common on the surface in the tropical Pacific, Fiji, and Malay Archipelago. It apparently does not descend into deep water.

In large medusæ the wide, flat, open stomach recalls that of *Ptychogena*. Maas found a single specimen with 5 lips and 5 radial-canals, and others had 5 or 6 canals. This variability recalls the condition characteristic of *Dipleurosoma*.

### Laodicea pulchra Browne.

*Laodice pulchra*, Browne, 1902, Annals and Mag. Nat. Hist., ser. 7, vol. 9, p. 280; *Ibid.*, vol. 20, p. 466.

Umbrella flatly curved, 25 mm. wide, 15 mm. high. About 50 tentacles without basal spurs. No marginal cirri, but 3 or 4 clubs (cordyli) between every two tentacles. Each cordylus situated on a small bulb. An ocellus is usually found at the base of every tentacle and cordylus. The stomach is very large with 4 large perradial lobes extending nearly to the margin of the umbrella. The mouth has 4 large lips. The gonads extend from near the stomach to within a short distance of the ring-canal. Found at Stanley Harbor, Falkland Islands, from November to February. Color (?) Briefly described, without figures, by Browne from specimens obtained by Vallentin. May this not be identical with *Laodicea cruciata*?

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### Laodicea? neptuna Mayer.

Plate 26, figs. 1-3.

*Laodicea neptuna*, MAYER, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 48, plate 20, figs. 50-52.—BROWNE, 1907, Annals and Mag. Nat. Hist., ser. 7, vol. 20, p. 469.

*Immature medusa (?).*—Bell little higher than a hemisphere and 2.5 mm. in diameter. There are 8 short tentacles with large basal bulbs and 8 small, rudimentary tentacle-bulbs. Tentacles thickly covered with nematocysts and usually carried coiled and contracted. A single, large, black ocellus is found at the base of each tentacle (plate 26, fig. 3). There are numerous small nematocyst-bearing cirri but no sensory-clubs upon the bell-margin between the tentacles. The velum is well developed. There are 4 straight, radial tubes, the upper regions of which, adjacent to the manubrium, are occupied by the gonads. The manubrium reaches slightly beyond the velar opening and the lips are surrounded by 4 prominent clusters of nematocyst-cells. The color of the entoderm of the manubrium, tentacle-bulbs, and circular and radial tubes is pearly-white. The entodermal lamella of the bell is of a delicate shade of green. This medusa was occasionally found at the Tortugas, Florida, during July and August, 1898. It has not been seen since that time. I can not be certain that this medusa is a *Laodicea* and share the doubts expressed by Browne, 1907, upon the subject.

### Laodicea? eucope.

*Octonema eucope*, HAECKEL, 1879, Syst. der Medusen, p. 127.—BROWNE, 1907, Annals and Mag. Nat. Hist., vol. 20, ser. 7, p. 477.

Bell hemispherical, 8 mm. wide. 8 equal tentacles, somewhat longer than the bell-diameter and with thick, globular, basal bulbs sharply set off from the long, delicate shafts of the tentacles. An abaxial ocellus with a subspherical lens on each tentacle-bulb. 60 to 80 marginal clubs. 30 to 40 spiral cirri as in *Laodicea cruciata*. 4 radial-canals. Stomach with 4 short, slightly-folded lips. 4 ribbon-like, folded gonads extending along the entire lengths of the 4 radial-canals. Color (?) Honolulu, Hawaiian Islands. The presence of abaxial ocelli may necessitate the removal of this medusa from the genus *Laodicea*.

### Laodicea? fertilis.

*Octorhopalon fertilis*, VON LENDENFELD, 1884, Proc. Linnean Soc. New South Wales, vol. 9, p. 919, plate 42, figs. 14-15.—BROWNE, 1907, Annals and Mag. Nat. Hist., ser. 7, vol. 20, p. 478.

Bell semi-ovate, 2.5 mm. high, 2 mm. wide. Stomach a 4-sided pyramid, widest in the middle, "octaedral." 4 simple lips. 8 tentacles, 4 radial and 4 interradial; longest tentacles two-thirds as long as bell-height; interradial ones shorter. Tentacle-bulbs elongate, but narrow and conical. There are 8 adradial clubs upon the bell-margin. These are longer than the tentacle-bulbs. The gonads are complexly folded and extend over the entire lengths of the 4 radial-canals and fuse one with another on the sides of the stomach. Gonads orange-yellow, other parts colorless. Sydney Harbor, New South Wales, Australia, in September.

A more detailed description is required before we can be certain of the actual affinities of this medusa, which appears to have been described from immature specimens?

### Laodicea? chapmani Günther.

*Laodicea chapmani*, GÜNTHER, 1903, Ann. and Mag. Nat. Hist., ser. 7, vol. 11, p. 425, plate 9, figs. 1-3. North Atlantic, off the Irish coast.

*Laodice (?) chapmani*, MAAS, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 25.—BROWNE, 1907, Annals and Mag. Nat. Hist., ser. 7, vol. 20, p. 469.

Bell 17 mm. wide, 12 mm. high. 32 tentacles, only 4 of which have ocelli. These 4 are at the bases of the 4 radial-canals. Marginal clubs (?) Cirri (?) 4 fimbriated, protrusive gonads on restricted parts of the 4 radial-canals somewhat nearer to the sides of the stomach than to the bell-margin. A single specimen taken between 1,070 fathoms and the surface off the Irish coast in N. lat. 52° 18′, W. long. 15° 54′.

The gonads do not touch the sides of the stomach. Is this an abnormal specimen of *L. cruciata* or does it belong to some genus other than *Laodicea*?

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## Plate 24.

Fig. 1. *Orchistoma tentaculata*, young medusa. Agassiz Laboratory, Newport, Rhode Island, August 18, 1896.

Fig. 2. *Melicertissa clavigera* Haeckel, Tortugas, Florida, June 2, 1906.

Fig. 3. *Melicertissa clavigera* Haeckel. One of the marginal sense-clubs of the medusa shown in figure 2.

Fig. 4. *Laodicea cruciata* var. *ulothrix*. Part of the bell-margin of the medusa shown in figure 2, plate 23.

Fig. 5. *Melicertum campanula*, half-grown medusa with the 4 secondary radial-canals beginning to develop. Nahant, Massachusetts, May 6, 1897.

Drawn from life, by the author.

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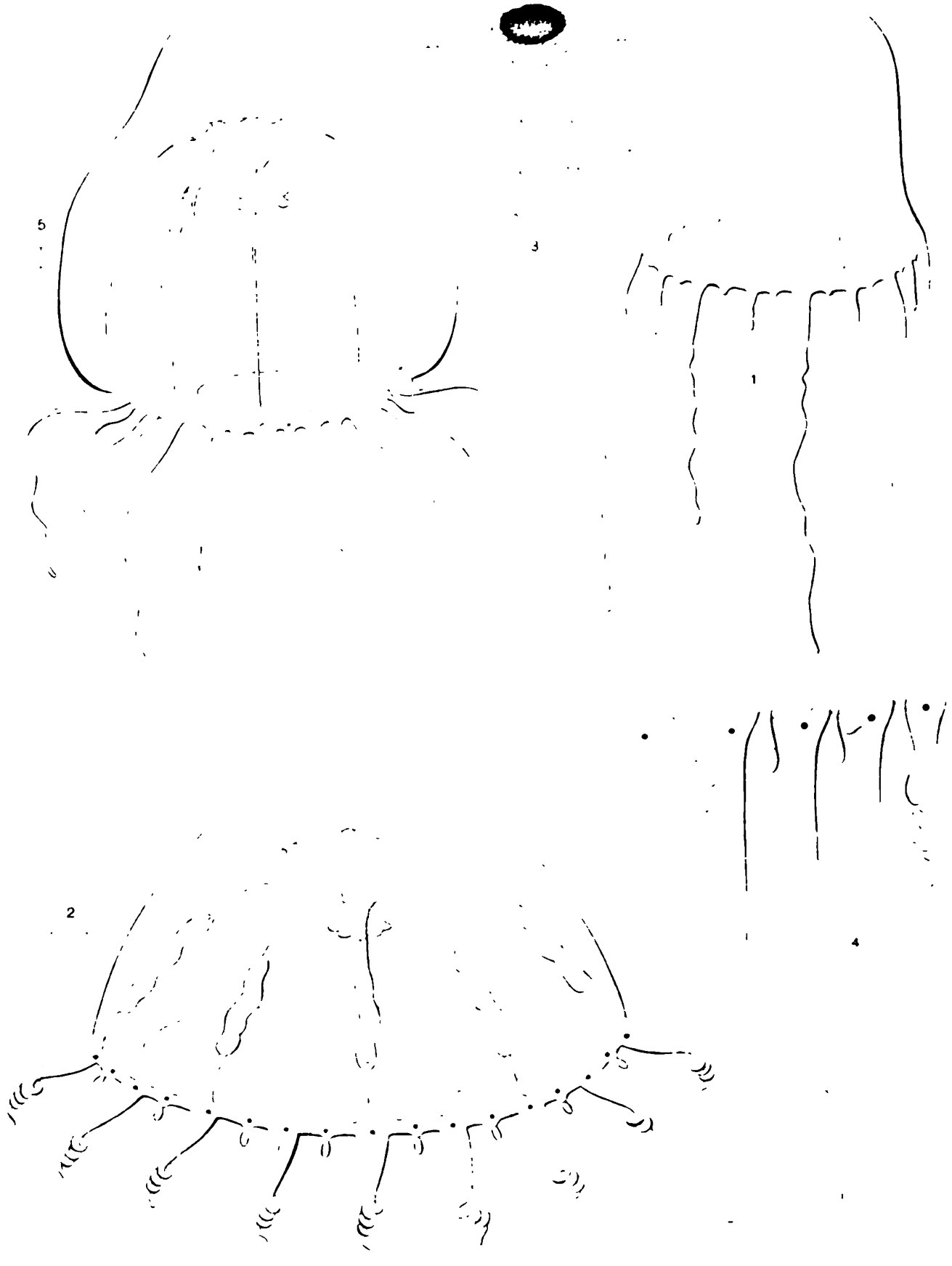


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### Genus MELICERTUM Oken (sensu Ehrenberg and Agassiz).

*Melicerta*, preoccupied by Schrank, 1803, for Rotifers. -Oken, 1815, Lehrbuch der Naturgesch., Bd. 1, Register p. 4, p. 125. Péron et Lesueur, 1809, Ann. du Mus. Hist. Nat. Paris, tome 14, p. 352. -Lesson, 1843, Hist. Zooph. Acal., p. 324.
*Melicertum*, Oken, 1835, Allgemeine Naturgesch. für alle Stande, Bd. 5, p. 226. Eschscholtz, 1829, Syst. der Acalephen, p. 105.—Ehrenberg, 1837, Abhandl. Akad., 1835, Berlin, p. 255. Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, pp. 349, 352.—Agassiz, A., 1862, Proc. Boston Soc. Nat. Hist., vol. 9, p. 96; 1865, North Amer. Acal., p. 130. -Maas, 1897, Mem. Mus. Comp. Zool. at Harvard College, vol. 23, p. 19. -Linko, 1904, Zool. Anzeiger, Bd. 28, p. 218.
*Campanella*, Morch, 1857, Beskriv af Grönland, p. 95.
*Melicertella + Melicertum*, Haeckel, 1879, Syst. der Medusen, pp. 134, 136.
*Melicertidium*, Browne, 1905, Proc. Royal Soc. Edinburgh, vol. 25, p. 764.

The name *Melicerta* appears, inadequately defined, in Oken's Lehrbuch, 1815, on page IV of the index and page 125 of the text. The same medusa is apparently described by Oken, 1835, under the name of *Melicertum campanula* from Greenland. In Oken's *Melicertum* there are but 4 radial-canals(?) and the stomach is tubular and quadratic in cross-section with 4 short lips. The marginal tentacles are of unequal length. It seems impossible to determine whether the medusa described by Oken is or is not the young of the *M. campanula* of Agassiz. The name "*Melicerta*" is preoccupied, and "*Melicertum*" would have been hopelessly lost through inadequate definition had it not been clearly defined by A. and L. Agassiz, 1862, 1865.

#### GENERIC CHARACTERS.

Thaumantiadæ with 8 gonads upon the 8 radial-canals. 8 or more tentacles. Without marginal sense-clubs or cirri. With or without a gastric peduncle. The hydroid is *Melicertum*.

*Melicertum* as here defined is equivalent to *Melicertum + Melicertella* of Haeckel, 1879. Hartlaub, 1894, and Browne, 1905, have discovered that *Oceania octocostata* Sars, 1835, lacks marginal cirri and has all of the characters of Agassiz's *Melicertum*. Haeckel labored under the false impression that this medusa had marginal clubs and he therefore established his new genus "*Melicertidium*" especially for this species. Browne would therefore amend *Melicertidium* and define it in the sense of the older genus *Melicertum*, doing away with *Melicertum*. But it appears that Ehrenberg, 1837, placed Sars's species in the genus *Melicertum*, and I think it should remain there and be considered a cotype of that genus.

### Melicertum campanula Oken (?), Agassiz.

Plate 23, figs. 4, 5; plate 24 fig. 5.

(?) *Melicertum campanula*, Oken, 1835, Allgemeine Naturg. für Alle Stande, Bd. 5, p. 226.
*Melicertum campanula*, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, pp. 349, 352 —Agassiz, A., 1862, Proc. Boston Soc. Nat. Hist., vol. 9, p. 96, figs. 18, 19; 1865, North Amer. Acal., p. 130, figs. 202-214.- -Haeckel, 1879, Syst. der Medusen, p. 137.—Nutting, 1901, Bull. U. S. Fish Commission for 1899, p. 382, fig. 104.—Hargitt 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 44.—Linko, 1904, Zool. Anzeiger, Bd. 28, p. 218.
*Melicertidium campanula*, Browne, 1905, Proc. Royal Soc. Edinburgh, vol. 25, p. 766.

*Adult medusa* (plate 23, fig. 5).—Bell pyriform in outline and about 25 mm. in height and 25 mm. in diameter. The gelatinous substance is quite thick, especially at the aboral pole. There are about 70 long, flexible tentacles with hollow, conical, basal bulbs. The tentacles arise from the bell-margin and are all longer than the bell-height. There are no marginal cirri or lithocysts between the tentacles, nor any ocelli. The velum is well-developed. There are 8 simple, straight, quite broad radial tubes. The manubrium is wide and shallow and does not extend quite half the distance from the inner apex of the bell-cavity to the velar opening. There are 8 simple, recurved lips. The 8 gonads occupy the entire lengths of the 8 radial-canals. These are longer than the canals upon which they lie and are reflected from one side to the other of the radial-canals in sinusoidal curves. The entoderm of the manubrium, gonads, and tentacle-bulbs is ocher-yellow, and the bell often displays a faint yellow tinge.

*Hydroid and young medusa*.—The eggs are cast into the water and develop into pear-shaped planulæ. The planulæ are ciliated and swim about near the bottom of the aquarium. They soon attach themselves by the blunt (foremost) end, and the narrow (hindermost) end then develops into a long, narrow trunk, which becomes the main stem of the hydroid. The distal extremity of the stem expands and forms the first polypite. The polypites are long, cylindrical, and protected by a small, funnel-shaped hydrotheca at their proximal ends.

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There is a circlet of 10 to 12 short, stout tentacles, the bases of which are connected by a web. At the end of six months the hydroid colonies were about 8 mm. in height.

In the youngest medusa observed the bell is about twice as high as broad and the bell-walls are thin and flexible. There are 2 well-developed, diametrically opposite tentacles and 2 small, undeveloped tentacle-bulbs. There are 4 straight, radial tubes. The manubrium is very small and there are 4 simple lips.

When the medusa is 1.5 mm. in diameter (plate 23, fig. 4) the bell has become relatively flatter and broader. There are now 8 tentacles, 4 long radial and 4 short interradial ones. There are, as yet, but 4 radial tubes and 4 lips. The bell-walls are still thin.

When the medusa is about 4 mm. in diameter (plate 24, fig. 5), the bell has become pyriform in shape and the gelatinous substance has greatly increased in thickness. There are 32 tentacles in several stages of development. There are 8 radial-tubes, 4 of which are broad, and 4 very narrow and almost thread-like. The 4 thread-like tubes are new and arise from the periphery of the stomach and extend down toward the circular vessel. The manubrium is shallow and there are 8 simple lips. The gonads begin at this stage upon the 4 broad radial-canals. The other 4 radial-canals acquire them later. The gonads first appear near the periphery of the stomach and extend down the radial-canals until they reach the circular tube.

This medusa is common on the New England coast, north of Cape Cod, during May and early June. It has not been taken south of Cape Cod. It is exceedingly abundant on the surface in Salem Harbor, Massachusetts, early in the summer, but disappears about the middle of July. The medusa is very constant to its type, individuals having more or less than 8 radial-canals being exceedingly rare. Linko finds it to be rare off the Murman coast, Northern Russia, near Norway.

*Melicertum octocostatum* (=*Oceania octocostata* Sars) of the northern Atlantic coasts of Europe is closely allied to, if not identical with, our American medusa.

### Melicertum octocostatum Haeckel.

*Oceania octocostata*, Sars, 1835, Beskriv og Jagttag, p. 24, plate 4, fig. 9 *a–d*.
*Melicertum campanulatum*, Ehrenberg, 1837, Abhandl. d. k. Akad. Wissen. zu Berlin (1835), pp. 190, 255, taf. 8, fign. 5–7.
*Thaumantias milleri*, Landsborough, 1847, Arran, a poem, p. 265.
*Stomobrachium octocostatum*, Forbes, 1848, British Naked-eyed Medusæ, p. 30, plate 4, fig. 1.—Romanes, 1876, Journal Linnean Soc. London, vol. 12, p. 526.
*Melicertum octocostatum*, *Melicertidium octocostatum*, Haeckel, 1879, Syst. der Medusen, p. 138.
*Melicertidium octocostatum*, Hartlaub, 1894, Wissen. Meeresuntersuch. Komm. Meere Kiel, Helgoland, Neue Folge, Bd. 1, p. 192.—Browne, 1905 Proc. Roy. Soc. Edinburgh, vol. 25, p. 762.—Bedot, 1905, Revue Suisse de Zool., tome 13, p. 138 (literature 1835–50).

Bell somewhat conical to pyriform, with thick, solid apex and thinner sides. About 11 to 13 mm. high and 10 to 11 mm. wide. There are about 64 large, alternating with 64 small, tentacles having laterally compressed basal bulbs and no ocelli. No clubs or cirri. Velum narrow. There are 3 to 5 fine, longitudinal lines of nematocyst (?) cells upon the subumbrella, extending from stomach to margin between each successive pair of radial-canals. These lines occasionally branch or anastomose. In large medusæ these lines are usually confined to parts near the margin, extending upward for a short distance only. Such lines have never been observed in the American *M. campanula*.

The stomach is octagonal, prismatic, one-fourth as long as the depth of the bell-cavity. It has 8 slightly crinkled lips. A short, broad peduncle is sometimes present. The 8 radial-canals are broad and straight, and the sinuous linear gonads extend along their outer two-thirds, reaching the bell-margin.

Color of gonads, stomach, and basal bulbs of large tentacles, yellow to yellowish-brown.

Found off the northern Atlantic coasts of Europe, Norway, Helgoland, Scotland. The best modern descriptions are given by Browne and Hartlaub.

This medusa appears to differ from the American *M. campanula* Agassiz in having fine radiating lines of nematocysts over its subumbrella. The gonads appear to be more restricted in their position upon the radial-canals, and the tentacles to be more markedly of two sizes in the European form. Nevertheless the two "species" are evidently closely related and may eventually prove to be identical. This is rendered probable on account of the Arctic range of *M. campanula* Agassiz.

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### Melicertum georgicum A. Agassiz.

*Melicertum georgicum*, AGASSIZ, A., in L. Agassiz's, 1862, Cont. Nat. Hist. U. S., vol. 4, p. 349; 1865, North American Acalephæ, p. 135, figs. 215, 216.—HAECKEL, 1879, Syst. der Medusen, p. 137.

Bell pointed above; 20 mm. high, 20 mm. wide. About 30 to 40 tentacles with large basal bulbs. No peduncle. Stomach wide, flat, and octagonal. Mouth long, with 4 (?) lips. 8 gonads covering nearly the entire lengths of the 8 radial-canals, but not touching the ring-canal. Manubrium, gonads, and tentacle-bulbs yellow.

Pacific coast of North America, State of Washington, in July.

Distinguished by its small number of tentacles and 4 (?) lips. Is it identical with *M. campanula* Agassiz?

### Melicertum panocto.

*Melicertella panocto*, HAECKEL, 1879, Syst. der Medusen, p. 135.

Bell is high, rounded, nearly barrel-shaped, 10 mm. high, 8 mm. wide. No marginal clubs or cirri. 8 tentacles longer than bell-diameter, with very large, globular basal bulbs. A black ocellus on each tentacle-bulb. The ocellus is flanked by a half-moon-shaped black spot on both sides. Stomach octagonal, prismatic, half as long as bell-height. 8 long, much folded, crinkled lips. 8 spindle-shaped gonads developed upon entire lengths of 8 radial-canals. Color (?) Azores, Atlantic.

Described by Haeckel from a preserved specimen. May it not be a specimen of *Melicertissa clavigera* which has lost its marginal clubs?

### Melicertum (?) Aglantha (?) proboscifer Maas.

*Melicertum proboscifer*, MAAS, 1897, Mem. Mus. Comp. Zool. at Harvard College, vol. 23, p. 19, taf. 2, figs. 5-7.

Bell rounded, 40 mm. wide, 15 mm. high; bell-walls quite thin. No apical projection. About 160 or more short, slender, tapering tentacles, nearly all of which were broken off short in the specimen studied by Maas. No lithocysts observed. Velum weakly developed. 8 straight, narrow radial-canals and a simple, marginal ring-canal. Stomach small, urn-shaped, and mounted upon a narrow, long, cylindrical peduncle as long as depth of bell-cavity so that the stomach projects beyond velar opening. There are 8 short, recurved, somewhat folded lips. 8 sausage-shaped gonads arise from middle of subumbrella lengths of the 8 radial-canals and project outward into bell-cavity.

Entodermal parts, including interstitial lamella of bell, intense carmine; tentacles rose-colored.

Found in the Gulf of Panama, Pacific coast of Central America, in March, 1891, by the *Albatross*.

I believe that future studies will show that this medusa is one of the Aglauridæ, possibly *Aglantha*. Its slender (solid?), brittle tentacles, 8 sausage-shaped gonads, and long, cylindrical peduncle are all characters of *Aglantha*. The lithocysts of Aglauridæ are often difficult to observe owing to their being readily lost, even in living medusæ, and in preserved specimens they are rarely detected. All known species of *Aglantha* have 4 lips, but this medusa is said to have 8; however, its general appearance is wholly unlike that of any other *Melicertum*, but closely resembles that of the known species of *Aglantha*.

## Genus MELICERTISSA Haeckel, 1879, sens. emend.

*Melicertissa* + *Melicertidium*, HAECKEL, 1879, Syst. der Medusen, pp. 124, 135, 137.
*Melicertidium*, MAAS, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 27.
*Melicertissa*, BROWNE, 1907, Annals and Mag. Nat. Hist., ser. 7, vol. 20, p. 476.

### GENERIC CHARACTERS.

Thaumantiadæ with 8 simple radial-canals upon which the 8 gonads are developed. 8 lips and 8 or more marginal tentacles. Marginal sense-clubs or cirri, or both, are present. Development unknown.



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Our *Melicertissa* is equivalent to *Melicertissa* + *Melicertidium* of Haeckel, 1879. Haeckel would restrict *Melicertissa* to include medusæ with only 8 tentacles, while *Melicertidium* would apply to medusæ with more than 8 tentacles. It is probable that *Melicertissa* as defined by Haeckel is only the young of his *Melicertidium*. His name *Melicertissa* precedes that of *Melicertidium* and should therefore designate the genus.

*Melicertissa* is closely related to *Melicertum*, but is distinguished by its rudimentary marginal sense-clubs or cirri which are absent in *Melicertum*.

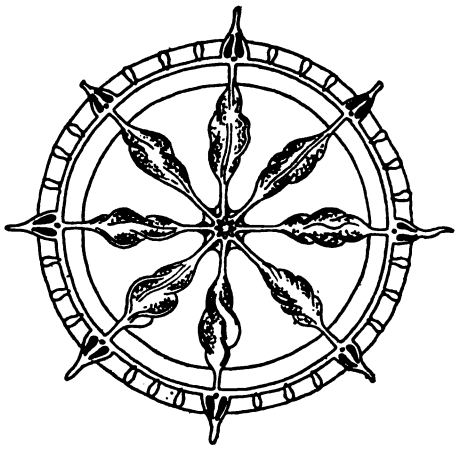
### Melicertissa clavigera Haeckel.

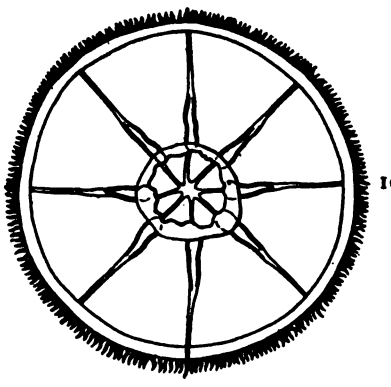
Plate 24, figs. 2 and 3.

*Melicertissa clavigera*, HAECKEL, 1879, Syst. der Medusen, p. 135, taf. 8, figs. 8–12.
(?) *Melicertella panocto*, HAECKEL, *Ibid.* p. 135 (a damaged specimen without marginal clubs?).

Bell 7 mm. in diameter, flatter than a hemisphere, with moderately thin walls becoming thinner toward margin. 16 marginal tentacles with long, hollow, tapering basal bulbs and coiled lash-like ends. When contracted these tentacles are each about half as long as the bell-diameter. 8 of the tentacles are radial and 8 interradial. There are 16 sense-clubs (plate 24, fig. 3) midway between the tentacles. There is a well-developed, black, entodermal, cup-like mass of pigment at the base of each tentacle and sense-club, 32 in all. In some specimens one or more of the interradial tentacles are replaced by a marginal sense-club. Haeckel, indeed, describes only 8 radial tentacles and 24 marginal sense-clubs, there being no interradial tentacles. His specimens were obtained in the Canary Islands. At Tortugas, Florida, however, we find specimens with interradial tentacles, but which conform in all other respects to Haeckel's medusa.

106.





107.

FIG. 106.—*Melicertissa clavigera*, after Haeckel, 1879.
FIG. 107.—*Melicertissa malayica*, after Maas, in Hydromedusen *Siboga* Expedition.

Velum well developed. There are 8 straight, narrow radial-canals and a simple, circular vessel. Stomach about one-fourth as wide as bell-diameter and the 8 radial-canals arise singly from its periphery 45° apart. Stomach flat and entire manubrium short and not over one-third as long as depth of bell-cavity. There are 8 short, simple lips. The gonads are linear, somewhat sinuous, and occupy the middle halves of the radial-canals, not touching the circular canal or edge of stomach.

Entoderm of stomach, radial and circular canals, and tentacle-bulbs dull yellow in specimens from Tortugas, Florida; the entodermal marginal ocelli black. Haeckel describes the color of the entoderm in the Canary Island specimens as being bronze-colored, brownish, or greenish-yellow.

Haeckel found this medusa at Lanzerote, Canary Islands, in January, 1867. We found it on the surface at Tortugas, Florida, early in June, 1906.

The American specimens are interesting, for they show that there is no natural distinction between the genera *Melicertissa* and *Melicertidium* of Haeckel. Parts of the bell-rim are

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usually in the "*Melicertissa*" condition with only 2 tentacles and 3 sense-clubs in each octant, while other parts of the rim of the same medusa are in the "*Melicertidium*" condition with 3 tentacles and 2 sense-clubs in each octant.

### Melicertissa malayica Browne.

*Melicertidium malayicum*, Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 28, taf. 5, figs. 29–31.
*Melicertissa malayica*, Browne, 1907, Annals and Mag. Nat. Hist., ser. 7, vol. 20, p. 477.

Bell flat, 32 mm. wide, 20 short tentacles in each octant, 160 in all. These tentacles are only about one-tenth as long as the bell-radius and their outer ends are coiled. They have slightly swollen basal bulbs. At the base of about every fourth tentacle there is an abaxial, ectodermal, swollen ocellus. Altogether there are 40 to 48 of these ocelli.

A number of small clubs arise from the margin between the tentacles. These are about half as numerous as the tentacles and are irregularly scattered around the margin. The cores of these clubs are filled with entodermal cells, as in *Laodicea*. A few small, coiled cirri, much fewer than the clubs, arise from the margin, each containing an axial core of entoderm.

Velum narrow. There are 8 straight, narrow radial-canals and a simple, slender ring-canal. Stomach flat, without a peduncle and with 8 simple, folded lips. Gonads linear and developed upon the sides of the proximal thirds of the 8 radial-canals, adjacent to stomach. The gonads begin to develop when the medusa is 18 mm. wide. The ocelli at the bases of the tentacles are black. (See figure 107, page 210.)

Malay Archipelago, Ternate. 2 specimens found by the *Siboga* expedition.

## Genus ORCHISTOMA Haeckel, 1879.

*Orchistoma*, Haeckel, 1879, Syst. der Medusen, p. 138.—Keller, 1884, Recueil Zool. Suisse, tome 1, pp. 417, 418.

The type species of this genus is *Orchistoma pileus*, described by Lesson (1843, p. 317, plate 6, fig. 1) under the name of *Mesonema pileus*. This species is believed to have come from the west coast of Africa.

### GENERIC CHARACTERS.

Thaumantiadæ with more than 8 simple radial-canals which arise separately from periphery of stomach. The gonads are situated upon the radial-canals. Numerous tentacles. Cirri or marginal sense-clubs may or may not be present.

*Mesonema* of Eschscholtz, 1829, is one of the Æquoridæ, and hence this generic name can not be applied to the type species of *Orchistoma*.

### Orchistoma pileus Lesson.

Plate 25, figs. 1 to 4.

*Mesonema pileus*, Lesson, 1843, Hist. Zooph. Acal., p. 317, planche 6, fig. 1.
*Orchistoma steenstrupii*, Haeckel, 1879, Syst. der Medusen, p. 139, taf. 15, figs. 3–5.—Keller, 1884, Recueil Zool. Suisse, tome 1, p. 417.

Bell flat-topped with vertical sides, 30 to 40 mm. in diameter. Gelatinous substance thick. 64 short tentacles with well-developed, hollow, basal bulbs; these tentacles are shorter than the bell-radius and are flat and ribbon-like, with hollow bulbs. About 100 small, solid, straight cirri from the side of exumbrella at a short distance above the bell-margin (plate 25, fig. 2). The entodermal cores of these cirri are connected with the entoderm of the circular canal. There are about 400 dark-brown, entodermal ocelli upon the circular canal. Each ocellus is provided with an ectodermal lens (plate 25, fig. 3).

Velum narrow. There are 32 straight, narrow radial-canals. The manubrium is provided with a large peduncle fully half as wide as bell-diameter and not quite as long as wide; it extends a short distance beyond the velar opening. The stomach is wide and shallow, and there are 32 long, complexly crenated lips (plate 25, fig. 4). There are 32 short, swollen, linear gonads, one upon each radial-canal very near its point of juncture with the stomach.

In the female the gonads are cinnamon-color, lips sage-green, tentacles ocher-yellow, and ocelli black. Other parts colorless. In the male, however, gonads, lips, and tentacle-bulbs are dull blue-gray.

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Lesson first found this medusa off the west coast of Africa (?). Haeckel describes it from the West Indies, and I have taken it upon the surface of the Gulf Stream off the Bahamas and near Tortugas, Florida, from March to July. The males greatly outnumber the females.

Distinguished from *O. agariciforme* Keller, from the Mediterranean, by having 32 lips instead of only 7, as in *O. agariciforme*.

Usually very rare, but abundant during the spring and summer of 1907, at Tortugas, Florida.

### Orchistoma agariciforme Keller.

*Orchistoma agariciforme*, KELLER, 1884, Recueil Zool. Suisse, tome 1, p. 418, taf. 21, fign. 1-3.

Found by Keller at Naples, Italy. Similar to *Orchistoma pileus* in all respects except that there are but 7 lips instead of 32, as in the Atlantic species. The color is not described by Keller, who found only one mature and one young specimen. Like the Atlantic form, it is very rare. 19 or more (about 32?) radial-canals. Keller states that the gonads are diverticula from the stomach which extend outward along the radial-canals.

### Orchistoma tentaculata Mayer.

Plate 24, fig. 1.

*Orchistoma tentaculata*, MAYER, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 8, plate 5, fig. 19.—NUTTING, 1901, Bull. U. S. Fish Com. for 1899, p. 377, fig. 92.—HARGITT, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 44, 1 fig.

*Young medusa.*—Bell 6 mm. in height. Sides near margin slightly flanged outward. Gelatinous substance of upper part of bell very thick, so that concavity is shallow. 32 marginal tentacles in various stages of development, the longest being about 1.5 times as long as bell-height. Tentacles with long, hollow basal bulbs. No marginal sense-organs. 16 functional radial tubes and 16 others in process of development. Radial tubes straight with no traces of gonads upon them. Velum well developed. Manubrium flat and shallow, 8 lips.

The entoderm of the basal bulbs of the tentacles delicate green.

Only one immature specimen of this medusa has ever been seen; no gonads were visible. It was found on the surface at Newport, Rhode Island, August 18, 1896.

Nutting states that the tentacle-bulbs are red. They are certainly green by reflected light, but probably red by transmitted light. Descriptions of color in this work are based upon the appearance presented by reflected light. Professor Nutting's figure and mine are drawn independently from the same specimen while yet alive.

The differences between this medusa and *O. pileus* are so considerable that it does not seem possible that the one can be the young of the other.

## Genus TIMOIDES Bigelow, 1904.

*Timoides*, BIGELOW, 1904, Bull. Mus. Comp. Zool. at Harvard College, vol. 39, p. 254.

The only known species is *Timoides agassizii* Bigelow, of the Maldive Islands, Indian Ocean.

### GENERIC CHARACTERS.

Thaumantiadæ with 4 radial-canals and a ring-canal which gives rise to blindly ending, centripetal canals. Stomach mounted upon a peduncle. Tentacles numerous, without lateral cirri. Numerous cirri upon bell-margin. There are no lithocysts. 4 gonads on the 4 radial-canals. Dr. Bigelow, upon re-examining his specimens, tells me that the medusa has no lithocysts.

### Timoides agassizii Bigelow.

*Timoides agassizii*, BIGELOW, 1904, Bull. Mus. Comp. Zool. at Harvard College, vol. 39, p. 254, plate 3, figs. 10, 11.

Medusa bell-shaped with rounded dome and flaring sides; 20 mm. wide, 14 mm. high, with very thick gelatinous substance at apex, but thin at margin. 32 tentacles, 4 radial, 4 interradial, 8 adradial, and 16 intermediate. The 4 radial tentacles are at the ends of the 4 radial-canals. The 4 interradial and 8 adradial tentacles are at the bases of the 12 interradial

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and adradial centripetal canals which arise from the ring-canal and end blindly in the gelatinous substance of the bell. The remaining 16 tentacles alternate with the radial and centripetal canals. All of these tentacles are exceedingly flexible and contractile; when contracted they are usually coiled helically, this coiling being more or less local and usually not affecting the entire length of the tentacle. When expanded, the tentacles are about 300 mm. long. In addition to the tentacles there are numerous cirri along the bell-margin, but no cirri arise from the sides of the tentacle-bulbs. No lithocysts upon the bell-margin.

The 4 radial-canals are straight and slender. There is a marginal ring-canal which gives off 12 blindly ending, centripetal vessels, the 4 interradial ones being about two-thirds as long as the bell-height, and the 8 adradial ones are only half this length. Velum well developed.

FIG. 108.—*Timoides agassizii*, after Bigelow, in Bull. Museum Comp. Zool. at Harvard College.

Peduncle nearly cylindrical, flaring at its base, and twice as long as depth of bell-cavity. The barrel-shaped stomach is almost as long as the peduncle and bears 4 lancet-shaped lips with complexly folded margins. These lips may be longer than the combined lengths of stomach and peduncle.

The 4 gonads are upon the lower half of the peduncle on the 4 radial-canals, above the stomach. They consist of a great number of simple and branched papilliform processes on both sides of the 4 radial-canals, thus forming 4 prominent, double ridges.

The gelatinous substance of the bell is faintly tinged with blue. The radial-canals and tentacles are rose-pink and there is a pink pigment-spot at base of each tentacle. Stomach and lips pink-violet. Gonads rich Indian yellow, changing in some lights to ruddy-orange.

This beautiful medusa was found by Dr. Bigelow in abundance in Haddummati Atoll, Maldive Islands, Indian Ocean, on January 8, 1902. It appears upon the surface at about 4 p. m.

### Genus STAURODISCUS Haeckel, 1879.

*Staurodiscus*, HAECKEL, 1879, Syst. der Medusen, p. 145. BROWNE, 1907, Annals and Mag. Nat. Hist., ser. 7, vol. 20, p. 475.
*New Staurodiscus*, AGASSIZ AND MAYER, 1899, Bull. Mus. Comp. Zool. at Harvard College, vol. 32, p. 164.
*Staurodiscus* (in part), MAAS, 1904, Sitzungsber. math.-phys. Klasse kgl. Bayer. Akad. der Wissenschaften, Bd. 34, p. 440.

This genus was founded by Haeckel, 1879, for *Staurodiscus tetrastaurus* found at the Canary Islands and off the Florida coast.

#### GENERIC CHARACTERS.

Thaumantiadæ with 4 radial-canals, each giving rise to 2 side branches which end blindly. The gonads are upon the 4 principal radial-canals and their side branches. There may or may not be marginal sense-clubs between the tentacles. Development unknown.

*Staurodiscus* is closely related to *Cannota*, but in *Cannota* the side branches of the radial-canals fuse with the circular vessel, whereas in *Staurodiscus* they end blindly. Maas, 1904, considers *Staurodiscus* to be the young of *Cannota*, and believes that the side branches of the radial-canals eventually fuse with the ring-canal. I have seen hundreds of medusæ of *Staurodiscus tetrastaurus*, evidently mature, but have never found the side branches fused with the ring-canal. *Cannota* doubtless passes through a "*Staurodiscus* stage," but on the other hand there appear to be medusæ which do not attain to the *Cannota* condition and must be called *Staurodiscus*. "*Staurodiscus*" *nigricans* Agassiz and Mayer should be called *Cannota*

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*nigricans*. It is probable that *Dipleurosoma brooksii* is derived from a *Staurodiscus* ancestor by the new formation of 4 interradial canals and the growing outward of the side branches of the perradial canals until they join the ring-canal.

### Staurodiscus tetrastaurus Haeckel.

Plate 22, figs. 7 and 8; plate 25, fig. 5; plate 26, figs. 10 and 11.

*Staurodiscus tetrastaurus*, HAECKEL, 1879, Syst. der Medusen, p. 145, taf. 9, fign. 1–3.—MAYER, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 46, plates 18, 19, figs. 47–49.—MAAS, 1904, Sitzungsber. math.-phys. Klasse kgl. Bayer. Akad. der Wissenschaft., Bd. 34, p. 440.—BROWNE, 1907, Annals and Mag. Nat. Hist., ser. 7, vol. 20, p. 475.
*Octonema gelatinosa* (young medusa), MAYER, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 8, plate 6, figs. 20, 21.

Bell 4.5 mm. in diameter, and about twice as wide as high. In adult medusæ there are 8 long, flexible tentacles with hollow basal bulbs. Some specimens have 24, others 16 sensory-clubs upon the bell-margin. 32 black entodermal ocelli, one at the base of each tentacle-bulb and sensory-club. Velum is well developed. Only 4 radial-canals reach the circular vessel. From the middle points of each of these canals there arises a pair of equally developed side branches that end blindly. The gonads are upon these side branches and on the distal part of each radial-canal. The manubrium bears 4 prominent lips. Entoderm green or yellow.

In the youngest specimen observed, the bell was 1 mm. in diameter and about as high as broad. There were 4 well-developed tentacles, 4 rudimentary tentacle-bulbs, and 8 marginal clubs. The medusa is common on the surface at Tortugas, Florida, in July and August. Haeckel found this species in the Canary Islands, at Lanzerote. I have seen hundreds of specimens at Tortugas and the side branches of the 4 radial-canals appear never to extend to the circular vessel.

### Staurodiscus heterosceles Haeckel.

*Staurodiscus heterosceles*, HAECKEL, 1879, Syst. der Medusen, p. 146.

This medusa resembles *S. tetrastaurus* Haeckel, excepting that the two side branches from each of the 4 radial-canals do not arise opposite one another from the middle of the radial-canals, but one branch is long and arises from the main canal near the stomach, while the other side branch is short and arises from the main canal beyond the middle point near the bell-margin. The long branches arise constantly from one, and the short branches from the opposite sides of the main radial-canals as one glances around the bell.

Bell hemispherical, 6 to 8 mm. wide. There are 8 to 32, usually 16, long tentacles with globular basal bulbs, and 40 to 80 marginal clubs between the tentacles. There is an ocellus at the base of each tentacle-bulb and marginal club. 12 club-shaped gonads, one at the outer end of each of the 4 main radial-canals, and one upon each side branch. Stomach, gonads, and tentacle-bulbs yellowish-brown. Ocelli black. Canary Islands, January, 1867, Haeckel. Development unknown.

## Genus PTYCHOGENA A. Agassiz, 1865.

*Ptychogena*, AGASSIZ, A., 1865, North Amer. Acal., p. 137.—HAECKEL, 1879, Syst. der Medusen, p. 147; 1881, Report on Deep-sea Medusæ, *Challenger* Report, Zool., vol. 4, part XII, p. 7.
*Non Ptychogena*, MAAS, 1893, Ergeb. der Plankton Exped., Bd. II, K. c., p. 64.
*Ptychogena*, LEVINSEN, 1893, Vid. Meddel. Nat. For. Kjöbenhavn, ser. 5, Bd. 4, p. 145.—LINKO, A., 1904, Zool. Anzeiger, Bd. 28, p. 217.—BROWNE, 1907, Annals and Mag. Nat. Hist. ser. 7, vol. 20, p. 473.—BIGELOW, 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 149.—TORREY, 1909, University California Publications, Zool., vol. 6, p. 13.

This genus was founded by A. Agassiz, 1865, for *Ptychogena lactea*, found in Massachusetts Bay.

### GENERIC CHARACTERS.

Thaumantiadæ with 4 radial-canals which in the mature medusa give rise to numerous, short, blindly ending side branches. The gonads are situated upon the radial-canals in the interspaces between the side branches, close to the subumbrella. The stomach is a wide, flat pouch and the mouth is a simple cruciform slit. The tentacles have no ocelli, and differ in this respect from those of *Laodicea*.

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## Plate 25.

Fig. 1 .*Orchistoma pileus*, mature medusa, female. Gulf Stream, Tortugas, Florida, July 4, 1906.

Fig. 2. *Orchistoma pileus*. Part of the bell-margin.

Fig. 3. *Orchistoma pileus*. One of the ocelli showing the ectodermal doubly convex lens and the entodermal pigment.

Fig. 4. *Orchistoma pileus*. One of the lips.

Fig. 5. *Staurodiscus tetrastaurus*. Side view of mature male. Tortugas, Florida, August, 1898.

Fig. 6. *Staurophora mertensii*, young medusa. Nahant, Massachusetts, May 7, 1897.

Figs. 7 and 8. *Dipleurosoma collapsa*, young stage in the growth of the medusa. Tortugas, Florida, and Nassau, Bahamas, July, 1902–03.

Drawn from life, by the author.

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### Ptychogena lactea A. Agassiz.

*Ptychogena lactea*, AGASSIZ, A., 1865, North Amer. Acal., p. 137, figs. 220–224; 1888, Bull. Mus. Comp. Zool. at Harvard College, vol. 15, p. 128, fig. 422.—HAECKEL, 1879, Syst. der Medusen, p. 147.—BROWNE, 1907, Annals and Mag. Nat. Hist., ser. 7, vol. 20, p. 473.
*Ptychogena pinnulata*, HAECKEL, 1879, Syst. der Medusen, p. 148; 1881, Report on Deep-sea Medusæ, Reports H. M. S. *Challenger*. Zool., vol. 4, part 12, p. 7, plate 2, figs. 1 to 8.—LEVINSEN, 1893, Vid. Meddel. Nat. For. Kjöbenhavn, ser. 5, Bd. 4, p. 145.—GRÖNBERG, 1898, Zoolog. Jahrb., Abth. Syst., Bd. 11, p. 465.
*Ptychogena pinnulata* var. *intermedia* LINKO, 1904, Zool. Anzeiger, Bd. 28, p. 217.

*Adult medusa.*—Bell about 50 to 70 mm. in diameter and 20 to 30 mm. in height. Sides of bell flange slightly outward. The gelatinous substance is about 10 mm. thick at aboral pole of bell, but diminishes constantly in thickness towards the margin. Substance of bell transparent, but quite rigid. There are more than 300 long, slender, highly contractile tentacles, with hollow, finger-shaped basal bulbs. When expanded these tentacles are about as long as the bell-diameter. Their free extremities often become entangled and this causes the tentacles to droop in graceful festoons from the bell-margin. There are 25 to 200 or more marginal sense-clubs. They arise on the inner (centripetal) side of the tentacle bases near the origin of the velum. These sense-clubs are elongate and pyriform, with a narrow basal stalk. They are between a third and a half as long as the basal bulbs of the tentacles. Each sense-club is hollow and connected with the lumen of the circular canal. In some places the sense-clubs are as numerous as the tentacles and often alternate with them in position, but on other parts of the bell-margin they are much less numerous than the tentacles. Velum very wide and thin. The 4 radial-canals are wide near their proximal ends, adjacent to manubrium, but straight and narrow near the circular vessel. These radial-canals are pinnated in their proximal halves, adjacent to the stomach. In this region they give rise to about 20 to 30 blindly ending, pinnate side branches, upon which the genital organs are situated. The genital organs consist of leaf-shaped sacs attached to the side branches of the radial-canals. The free outer edges of these sacs are serrated or split up into a number of finger-shaped points. Thus each genital gland consists of 20 to 30 leaf-shaped sacs or lamellæ, all connected with the main axis of the radial-canal. Manubrium wide and shallow. The 4 corners of the fundus of the stomach are prolonged into 4 conical funnels, whose ends extend to the middle of the genital organs and occupy the proximal halves of the 4 radial-canals. Mouth-opening quadrate and about one-third as wide as bell-diameter. Lips irregularly frilled and extend at the 4 radial corners into 4 short, wavy, oral lobes. 4 narrow, ciliated grooves extend along umbrella wall of the 4 radial-canals and meet at center of stomach on gastral surface of gelatinous umbrella, forming a cross. The gonads and tentacle-bulbs are milky in color and the marginal sense-clubs are white. All other parts of the medusa are transparent.

This medusa appears to be an Arctic form. It was first found by A. Agassiz swimming at considerable depth in Massachusetts Bay. Since then specimens have been described by Haeckel, under the name of *Ptychogena pinnulata*, from the North Atlantic Ocean between Ireland and Iceland (lat. 50° 7′ N., long. 13° 32′ W. from Greenwich). The *Challenger* also dredged a specimen between 1,250 fathoms and the surface near Halifax, Nova Scotia. Levinsen, 1893, records this medusa from Jakobshavn and Ritenbenk on the west coast of Greenland, and Linko found it in Barents Sea in 72° 30′ N. lat., both in the eastern and western parts of the sea north of Lapland.

I believe that *P. pinnulata* of Haeckel, 1879, is identical with *P. lactea* of A. Agassiz, 1865. Upon comparing Agassiz's original figures (some of them unpublished) with those of Haeckel, it appears that the only difference which may exist between the two forms is that in *P. pinnulata* the free, outer edges of the leaf-like gonads are serrated, whereas in *P. lactea* of Agassiz they appear to be entire and smooth. Also in Agassiz's figures some of the side branches of the radial-canals give rise to secondary branches, and this appears not to be the case in Haeckel's *P. pinnulata*. Agassiz's specimens were, however, larger than those described by Haeckel, and probably they may have been more mature.

Linko, 1904, found a medusa in Barents Sea which he considers to be intermediate between *P. lactea* and *P. pinnulata*, but nearer to *P. pinnulata*.

It is possible that this medusa is an inhabitant of the deep-sea and that it comes to the surface only occasionally.

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As A. Agassiz says:

"The action of the light and increase of temperature of the surface is sufficient to kill them in the course of half an hour; the moment they are brought to the surface, the bell loses its transparency, the genital organs become dull and the medusa is soon completely decomposed. This action is much more rapid than anything of the kind which I have noticed, even in Ctenophoræ, *Mertensia* being the only genus in which the decomposing effects of light and heat are at all equal to what is produced here. This jelly-fish must be a deep-water species, as they have only been found during a single autumn, and then only for a few days, when they seemed quite abundant."

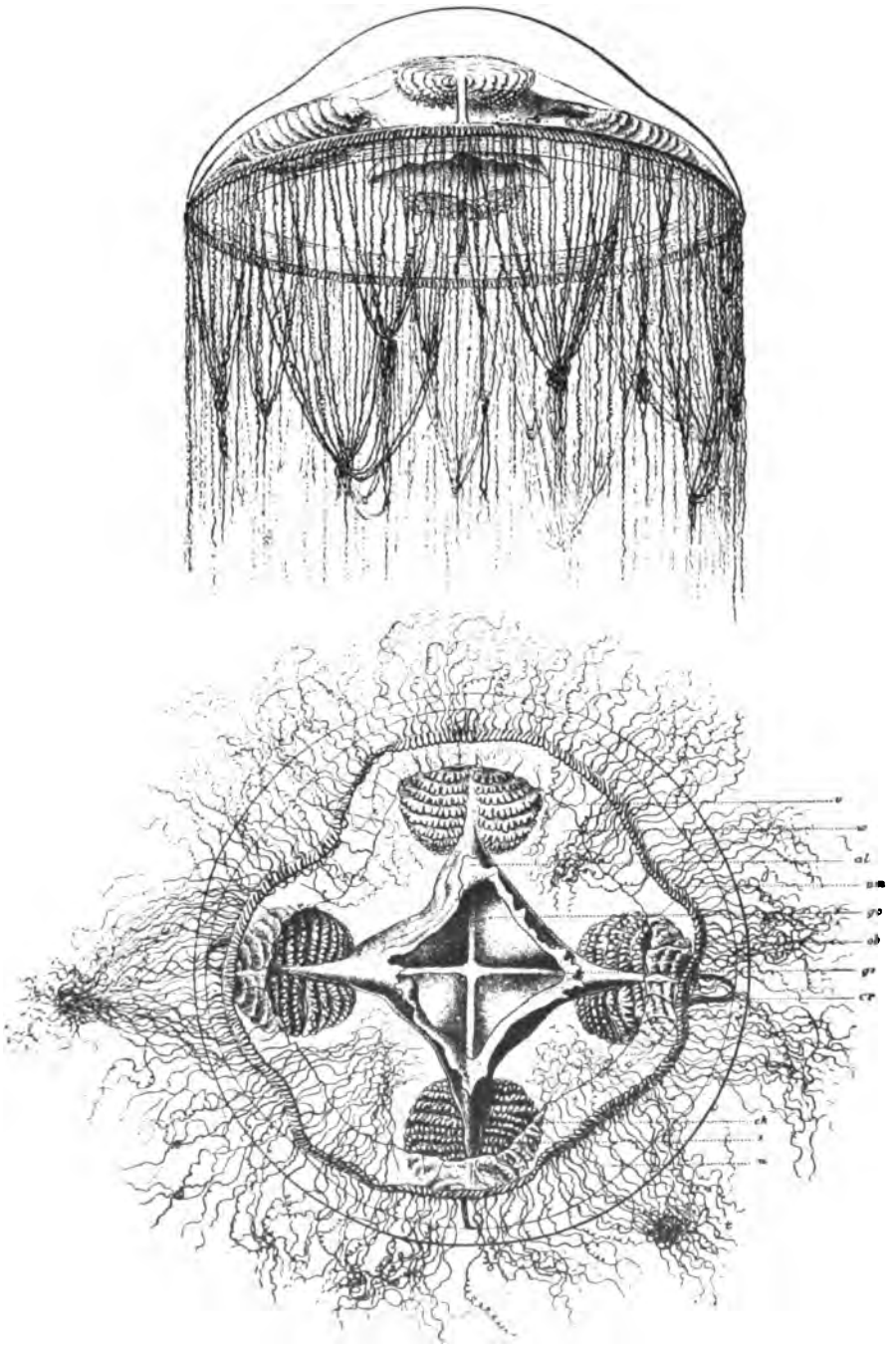

FIG. 109.—*Ptychogena "pinnulata"* = *P. lactea*, after Haeckel, in Report. *Challenger* Expedition, Deep-Sea Medusæ. *v*, velum; *w*, subumbrella; *al*, lips; *um*, umbrella-margin; *gc*, stomach cavity; *ob*, marginal clubs; *gs*, ciliated perradial cruciform furrow in the aboral wall of the central stomach; *cn*, outer part of one of the radial-canals; *ck*, distal funnel-like part of one of the radial-canals; *s*, gonad; *u*, umbrella; *t*, tentacles.

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Linko also considers *Ptychogena* to be a deep-sea form; as Browne, 1907, and Bigelow, 1909, state, however, we have no trustworthy evidence upon this point and it is not improbable that the medusa is merely a rare and somewhat variable Arctic species which lives constantly at or near the surface.

### Ptychogena longigona Maas.

*Ptychogena longigona*, Maas, 1893, Ergeb. der Plankton Exped., Bd. 2, K. c., pp. 64, 97, taf. 6, figs. 7–9.
*Ptychogena (?) longigona*, Browne, 1907, Annals and Mag. Nat. Hist., ser. 7, vol. 20, p. 474.

Bell 25 mm. wide, flat, with firm gelatinous substance. About 100 tentacles very closely set side by side so that they form an outer row around the margin, on the outer side of which is a row of marginal clubs. Circular canal simple, but the 4 wide radial-canals have numerous, indistinct, unbranched diverticula along their sides, the spaces between the lateral branches of the canals being nearly filled in by the gonads. Stomach shallow and 4-cornered and about one-fourth as wide as the diameter of the bell. The mouth is a wide cruciform opening with lips turned back as in *Ptychogena*, so that the water may enter the wide openings of the 4 radial-canals at the corners of the stomach. The gonads cover the entire lengths of the 4 radial-canals and their lateral surfaces give rise to hollow, evaginated, sac-like elevations or papillæ, which are neither so complex nor so regularly arranged as in *Ptychogena*. These papillæ occur along either side of each radial-canal, but not in the median line. The mature genital products are in the ectoderm. The grooves of the 4 radial-canals extend along the upper wall of the stomach and meet in the middle. Color (?)

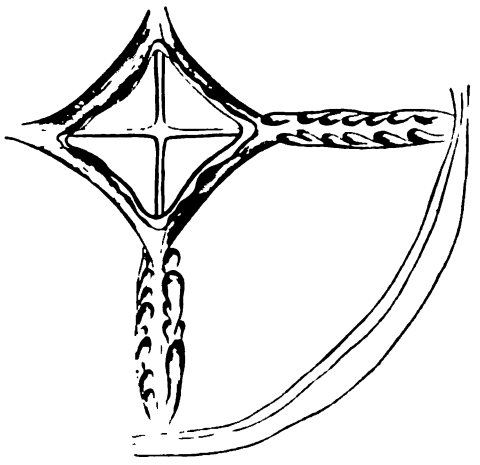

Fig. 110. –*Ptychogena longigona*, after Maas, in Ergeb. Plankton Expedition.

The species was found by the Plankton expedition in the North Atlantic at a depth of 100 to 200 fathoms, but Maas does not give the exact locality. As he states, it may prove to be only a local variety of *Ptychogena pinnulata* (*lactea*). It differs from *Ptychogena lactea*, however, in the simple side branches upon the radial-canals and in that the gonads extend along the entire length of the sides of the radial-canals, not being restricted to their middle parts as in *Ptychogena lactea*. The hollow elevations upon the gonads are also simple and not so regularly arranged as in *P. lactea*.

Medusæ somewhat similar to *P. longigona* were found by the Plankton expedition near the Cape Verde Islands.

### Ptychogena? antarctica Browne.

*Ptychogena antarctica*, Browne, 1907, Annals and Mag. Nat. Hist., vol 20, ser. 7, p. 474.

The basal bulbs of the tentacles are laterally compressed and without ocelli. They resemble those of *P. lactea*. Number of tentacles(?) Sensory-clubs(?) The 4 radial-canals have wavy outlines, but no lateral branches. The wavy outlines of the radial-canals correspond with those of the gonads, which are broad, lateral folds extending only part way along the radial-canals. The stomach was lost in the single specimen studied by Browne. The tentacles are red. Size of medusa(?)

Found off Cape André, Victoria Land, Antarctic Ocean.

### Ptychogena erythrogonon Bigelow.

*Ptychogena erythrogonon*, Bigelow, H. B., 1909, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 150, plates 5, 38, and 39.

This medusa is beautifully figured and well described by Bigelow.

Bell 38 mm. wide, 25 mm. high with very thick gelatinous substance and shallow bell-cavity. 40 to 60 tentacles about one-fourth as long as bell-diameter and with tapering, conical basal bulbs. There are only a very few cirri between the tentacles and these ter-

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minate in a knob-like cluster of nematocysts. Some of the medusæ lack cirri and Bigelow never saw more than 3 upon a single medusa. The cordyli or clubs upon the bell-margin are more numerous than the tentacles. There are no lithocysts and no ocelli. When young the outlines of the 4 broad radial-canals are plain. Later they develop short, simple, lateral diverticula and then the gonads develop in the interspaces of these branches close to the subumbrella as in *P. longigona*. The manubrium is quadrate basally and its side walls are short and barrel-shaped with a widely open mouth.

Basal parts of radial-canals, manubrium, and tentacle bulbs are brilliant opaque brick-red; gonads and outer parts of canal system and tentacles lighter. A pale colored line extends along the central line of each radial-canal forming a cross at the middle of the stomach. The entoderm cells contain red, yellow, and black granules, and the ectoderm cells minute, red granules.

This medusa is one of the intermediate fauna found at depths of about 300 fathoms in the Humboldt Current off the coast of Peru. Torrey describes another species of *Ptychogena* from the California coast. (See appendix.)

### Genus POLYORCHIS A. Agassiz, 1862.

*Polyorchis*, A. Agassiz in L. Agassiz's, 1862, Cont. Nat. Hist. U. S., vol. 4, p. 349; 1865, North Amer. Acal., p. 119.—Haeckel, 1879, Syst. der Medusen, p. 149.—Murbach and Shearer, 1903, Proc. Zool. Soc. London, vol. 2, p. 174.

The type species is *Polyorchis penicillata* A. Agassiz, from the Pacific coast of the United States.

#### GENERIC CHARACTERS.

Thaumantiadæ with 4 radial-canals which give rise throughout their lengths to many blindly ending side branches. Marginal ring-canal simple and bell-margin not divided into lobes. Numerous sac-like, sausage-shaped gonads attached to the radial-canals and their side branches. Stomach long, tubular, and with 4 simple lips.

### Polyorchis penicillata A. Agassiz.

(?) *Medusa campanulata*, de Chamisso et Eysenhardt, 1820, Nova Acta Phys. Med. Leop. Car., tome 10, p. 359, plate 30, fig. 1.
*Melicertum penicillatum*, Eschscholtz, 1829, Syst. der Acalephen, p. 106, taf. 8, fig. 4.
*Aglaura penicillata*, de Blainville, 1834, Man. d'Actinologie, p. 283, plate 33, fig. 4.
*Polyorchis penicillata*, A. Agassiz in L. Agassiz's, 1862, Cont. Nat. Hist. U. S., vol. 4, p. 349.—Agassiz, A., 1865, North Amer. Acal., p. 119, figs. 179–183.—Fewkes, 1889, Amer. Naturalist, vol. 23, p. 593, figs. 3, 4; 1889, Bull. Essex Inst. Salem, vol. 21, No. 7, p. 103, plate 4, figs. 6, 7.—Bancroft, 1904, Journ. Exper. Zool., Baltimore, vol. 1, p. 289, 4 figs. (reactions to galvanic currents).—Bancroft, 1906, University of California Publications, Physiol., vol. 2, p. 43, 4 figs.
*Polyorchis pinnatus* + *P. penicillatus*, Haeckel, 1879, Syst. der Medusen, pp. 149, 150, taf. 8, fig. 13.
*Polyorchis* ——, Loeb, 1906, Journ. Biological Chemistry, New York, vol. 1, No. 6, p. 427 (physiological).
*Polyorchis campanulata* + *P. penicillata*, Bedot, 1905, Revue Suisse de Zool., vol. 13, pp. 143, 144 (citation of all papers to 1850).
*Polyorchis* ——, Loeb, 1906, Dynamics of Living Matter, Columbia Univ. Biol. Series, No. 8, pp. 87, 91, 141.
*Polyorchis* ——, Maccallum, 1907, The Journal of Biol. Chemistry, vol. 2, No. 4, p. 385, New York.

Bell about 50 to 60 mm. high, 30 to 40 mm. wide, with a slight, solid, apical projection and almost vertical, slightly bulging sides. Gelatinous substance quite thin. 36 to 40 tentacles arise in a single row from the bell-margin. They are equal each to each and are longer than the bell-height. Their basal bulbs are large, elongate, and spindle-shaped, and have dark-purple pigment. There are no other marginal appendages. Velum narrow. Ring-canal simple and unbranched, but the 4 radial-canals give rise each to 15 to 25 pairs of simple, short, unbranched, blindly ending, lateral diverticula. Stomach prismatic with a very short peduncle, and nearly as long as depth of bell-cavity. There are 4 short lips with sinuously folded margins. A row of 4 to 8 elongate, sac-like, sausage-shaped gonads arises from the sides of each of the 4 radial-canals between the sides of the stomach and the feathered (branched) parts of the canals, there being in all 16 to 32 of these suspended gonads.

Stomach, gonads, tentacle-bulbs, and radial-canals reddish-brown to purple.

Found on the Pacific coast of California to Washington, and as far westward as the Hawaiian Islands.

Fewkes found the medusa abundant in bays along the California coast in March and April. He states that when the medusa has 16 tentacles the 4 radial-canals were merely beginning to exhibit notches along their sides and the gonads were beginning to appear at the 4 corners of the stomach. When mature, the medusa has about 36 tentacles.

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PLATE 26.

Figs. 1 and 2. *Laodicea? neptuna.* Tortugas, Florida, July, 1898.

Fig. 3. *Laodicea? neptuna.* Part of the bell-margin.

Fig. 4. *Staurophora mertensii*, half-grown medusa. Nahant, Massachusetts.

Fig. 5. *Staurophora mertensii.* Part of the bell-margin of the medusa shown in figure 4.

Fig. 6. *Staurophora mertensii*, mature medusa, natural size. Agassiz Laboratory, Newport, Rhode Island, June 9, 1895.

Fig. 7. *Staurophora mertensii.* Portion of the bell-margin of the medusa shown in figure 6.

Fig. 8. *Staurophora mertensii.* Aboral view of the mid-region of one of the radial-canals of the medusa shown in figure 6.

Fig. 9. *Staurophora mertensii.* Oral view of the mid-region of one of the radial-canals of the medusa drawn in figure 6. This shows the curtain-like folds of the gonads.

Fig. 10. *Staurodiscus tetrastaurus*, young medusa. Tortugas, Florida, July, 1898.

Fig. 11. *Staurodiscus tetrastaurus.* Oral view of female. Tortugas, Florida, July, 1898.

See page 206 for description of figures 1 to 3.

Drawn from life, by the author.

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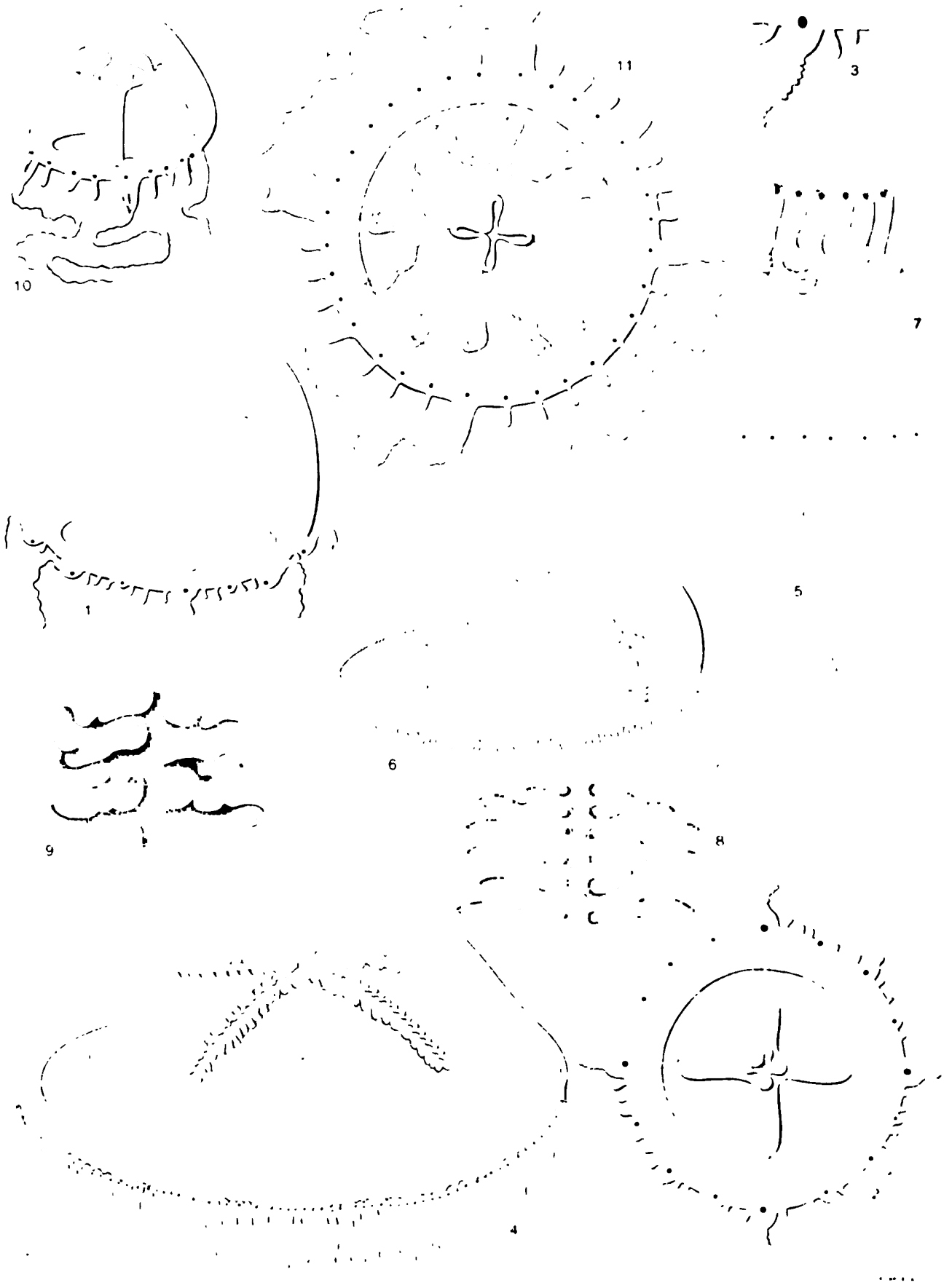


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Bancroft, 1904–06, carried out an interesting series of observations upon the galvanotropic reactions of the medusa, showing that the tentacles and manubrium respond definitely to the current, even detached parts of the tentacles reacting. The maximum response is at the anode side in sea-water, whether acid or alkaline. The tentacles and manubrium turn and point toward the cathode. The tentacles may be caused to contract slowly and irregularly in a constant current. They contract when the current is made and relax when it is broken.

Loeb, 1906, finds that the magnesium of the sea-water serves to relax the muscles of the bell, stomach, and tentacles of *Polyorchis;* and that the remaining salts of sea-water produce a state of contraction, so that if we place the medusa in any solution resembling sea-water, but lacking magnesium, pulsation is impossible and the tentacles and stomach are contracted. If we add magnesium, however, pulsation is resumed, but this effect of magnesium can be inhibited by addition of an equivalent amount of calcium or potassium.

The isolated center of the bell will not beat in sea-water or in a sugar solution, but beats commence in these solutions if we add calcium, strontium, or barium chlorides. No beats occur, however, if we add magnesium chloride. The isolated center will beat for 3 to 4 hours in any decalcifying salts, such as oxalates, fluorides, oleates, citrates, etc. Acids cause the center to beat, while alkalies inhibit such beats.

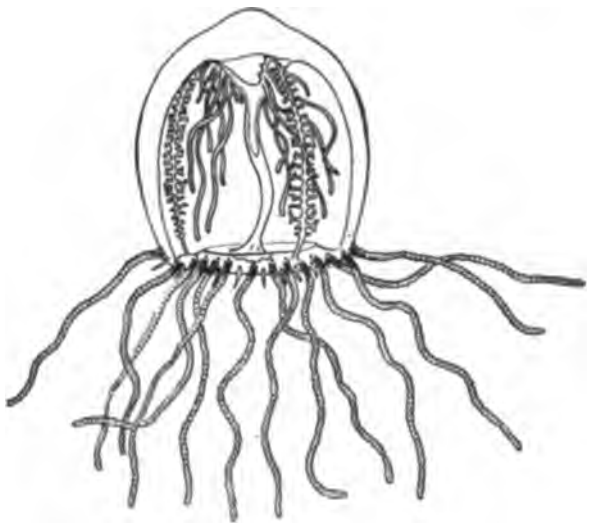

FIG. 111.—*Polyorchis penicillata*, after Fewkes, in American Naturalist.

The center does not beat until some hours after being placed in NaCl; but then rhythmical pulsations set in and may last 2 or 3 days. But pulsation may be at once produced in NaCl by adding salts which precipitate calcium, such as sodium citrate, tartrate, or oxalate. A trace of HCl or $CO_2$ added to NaCl will also cause beats, as will pure solutions of $CaCl_2$, $BaCl_2$, or $SnCl_2$. Beats are inhibited more by Mg than by Ca. We have thus the anomaly that contractions occur in an excess or a deficiency of Ca.

Maccallum, 1907, finds that solutions of cascara sagrada, rhubarb, aloin, podophyllin, and colocynth produce temporary pulsations in the isolated center of *Polyorchis*.

### Polyorchis minuta Murbach and Shearer.

*Polyorchis minuta*, MURBACH AND SHEARER, 1903, Proc. Zool. Soc. London, vol. 2, p. 174, plate 19, fig. 3; plate 22, fig. 1; 1902, Annals and Mag. Nat. Hist., ser. 7, vol. 9, p. 72.

Bell 15 mm. high, 12 mm. broad. Truncated, oval, with thick walls; only 9 mm. wide at velar margin. There are 55 or more tentacles. Yellow ocelli on outer sides of tentacle bases on elevations. 4 narrow radial-canals with short, lateral diverticula. Stomach mounted on a long peduncle extending to level of velar opening. 4 crenated lips. Gonads long, finger-shaped, arising from the 4 radial-canals near base of peduncle.

Gonads and tentacles pale yellow in preserved specimens, other parts colorless.

Found in Puget Sound, British Columbia.

### Genus SPIROCODON Haeckel, 1880.

*Spirocodon*, HAECKEL, 1880, Syst. der Medusen, p. 636.
*Gonocmeandrus*, KIRKPATRICK, 1903, Annals and Mag. Nat. Hist., ser. 7, vol. 12, p. 616.

The type species and only known form is *Spirocodon saltatrix* of the Inland Sea, Japan. This was first described by Tilesius, 1818, as *Medusa saltatrix*. Haeckel, 1880, established it as a type of the genus *Spirocodon*.

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GENERIC CHARACTERS.

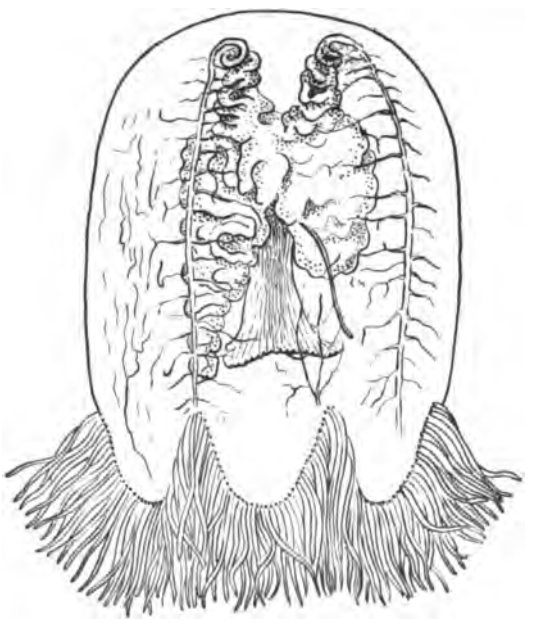
Thaumantiadæ with 4 radial-canals and a ring-canal, all of which give off blindly ending, dendritic side branches. Bell-margin cleft into lappets. Stomach mounted upon a peduncle, and with 4 lips. Gonads sac-like, complexly folded, and developed upon the radial-canals adjacent to sides of stomach.

This genus resembles *Polyorchis*, but ring-canal gives off blindly ending, centripetal branches, and margin is cleft into lappets.

**Spirocodon saltatrix Haeckel.**

*Medusa saltatrix*, TILESIUS, 1818, Mém. Acad. St. Pétersbourg, tome 6, p. 554, taf. 18.
*Polyorchis saltatrix=Spirocodon saltatrix*, HAECKEL, 1880, Syst. der Medusen, p. 636.
*Spirocodon saltatrix*, GOETTE, 1886, Sitzungsber. kgl. Preussisch. Akad. Wissenschaft. zu Berlin, Jahrg., 1886, p. 832.
*Goneomeandrus chrysostephanus*, KIRKPATRICK, 1903, Annals Mag. Nat. Hist., ser. 7, vol. 12, p. 616, plate 33, figs. 1–4 (this is *Spirocodon saltatrix* Haeckel; see Kirkpatrick, 1904, Annals and Mag. Nat. Hist., ser. 7, vol. 13, p. 80).

Bell with octagonal sides and dome-like, rounded top, angles of side-walls radial and interradial in position, 30 to 60 mm. wide, 50 to 80 mm. high. 8 adradial, semicircular, marginal lappets. The clefts between the lappets pass obliquely upward and outward from below and extend much higher on the exumbrella than on the subumbrella side, so that only the outer third of each lappet is free. The lappets alternate in position with the angles of the sides of the bell. Velum quite broad, its inner edge circular.



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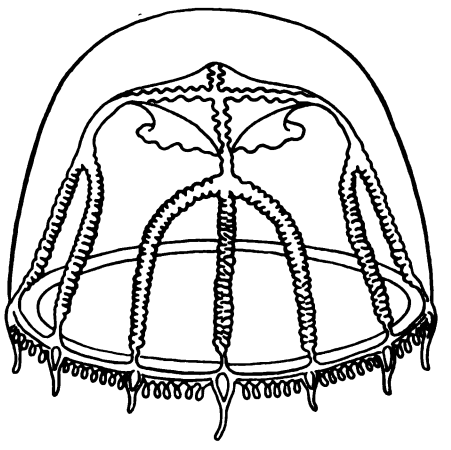

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FIG. 112.—*Spirocodon saltatrix*, after Kirkpatrick, in Annals and Mag. Nat. Hist.
FIG. 113.—*Cannota dodecantha*, after Agassiz and Mayer, in Bull. Museum Comp. Zool. at Harvard College.

There are about 40 to 80 tentacles on each of the 8 lappets, 320 to 640 in all. These tentacles arise in a single row from the margin, and are about one-third as long as bell-diameter. Their bases are hollow and narrower at margin than at some distance out. There is an orange-brown ocellus above the base of each tentacle and there are no other marginal sense-organs. There are 4 radial-canals and a ring-canal which extends around the margins of the lappets. All of these canals give off numerous blindly ending, dendritic side branches, which do not anastomose. 4 main centripetal vessels arise from the interradial angles of the marginal ring-canal and smaller ones arise from the ring-canal in adradial and other positions.

The stomach is set upon a short, gelatinous peduncle which is one-third as wide as the bell itself and as long as wide; it is cruciform in cross-section, 4-sided, and about half as long as

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bell-height. There are 4 slightly recurved lips with sinuously folded margins. The gonads are complexly folded, swollen, projecting masses on proximal parts of the 4 radial-canals, upon the peduncle adjacent to the stomach. The bell is colorless, gonads pale yellow, ocelli orange to brown. Found at Nagasaki, Inland Sea, Japan.

### Genus CANNOTA Haeckel, 1879.

*Cannota*, HAECKEL, 1879, Syst. der Medusen, p. 151.
*Staurodiscus* (in part), MAAS, 1904, Sitzungsber. math.-phys. Klasse kgl. Bayer. Akad. Wissenschaft., Bd. 34, p. 440.

The type species is *Cannota dodecantha* Haeckel, from New Guinea, tropical Pacific.

#### GENERIC CHARACTERS.

Thaumantiadæ with 4 main radial-canals, each giving rise to 2 simple, unbranched side branches which, together with the main radial-canals, connect with ring-canal at margin. Gonads upon the 4 main canals and side branches. Marginal clubs and cirri may or may not be present. 12 or more tentacles.

This genus is closely related to *Staurodiscus*, but is distinguished by the fact that the side branches of the radial-canals join the marginal ring-canal, whereas in *Staurodiscus* they end blindly.

Maas, 1904, would regard *Staurodiscus* as a young stage of Haeckel's *Cannota*, but my studies of numerous specimens of *Staurodiscus* at Tortugas, Florida, convince me that the medusæ become mature with blindly ending side branches upon the 4 main radial-canals.

### Cannota dodecantha Haeckel.

*Cannota dodecantha*, HAECKEL, 1879 Syst. der Medusen, p. 151.
*Staurodiscus nigricans*, AGASSIZ, A., AND MAYER, 1899, Bull. Mus. Comp. Zool. at Harvard College, vol. 32, p. 164, plate 4, figs. 11, 12.—BROWNE, 1907, Annals and Mag. Nat. Hist., vol. 20, ser. 7, p. 475.

Bell thin and flexible, 14 mm. in diameter. 12 short tentacles with well-developed basal bulbs. The 4 tentacles at the bases of the 4 main canals are about twice as long as the 8 which arise from the ends of the lateral branches. The longest tentacles are, however, only about one-sixth as long as bell-diameter. Between each successive pair of tentacles there are 7 small protuberances upon the bell-margin, each one of which bears a sensory-club. Velum narrow. Each of the 4 radial-canals gives rise to a pair of opposed lateral branches and thus 12 canals reach the circular vessel 30° apart. The gonads are developed upon these 12 trident-like terminal canals. Manubrium is very short, mouth-opening wide. Gelatinous substance and entodermal lamella of bell of a brownish tinge. Genital organs, basal bulbs of tentacles, and manubrium are light-sepia in color. Bulbs of sensory-clubs are dark-brown.

This medusa was found near Suva Harbor, Fiji Islands, South Pacific, in December, 1897. Haeckel describes a small specimen 4 mm. wide from New Guinea. (See fig. 113.)

### Genus CUVIERIA Péron, 1807.

*Cuvieria* (in botany), KORREUTER, 1802; DE CANDOLLE, 1807.
*Cuvieria* (medusa), PÉRON, 1807, Voyage aux terres australes, plate 30, figs. 2, 2a. AGASSIZ, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 345.
*Cuvieria* (echinoderm), PÉRON, 1817.
*Cuvieria* (crustacean), DESMAREST, 1825.
*Cuvieria* (mollusk), RANG, 1828.
*Berenix*, PÉRON ET LESUEUR, 1809, Annal. du Mus. Hist. Nat. Paris, tome 14, p. 327.
*Berenice*, OKEN, 1815, Lehrbuch der Naturgesch., Teil 3, Zool., p. 114.- ESCHSCHOLTZ, 1829, Syst. der Acalephen, p. 120.—MILNE-EDWARDS, 1849, Cuvier's Règne animal illustré, Zooph., plate 53, fig. 1, 1a.—HAECKEL, 1879, Syst. der Medusen, p. 152.—MAAS, 1904, Sitzungsber. math.-phys. Klasse kgl. Bayer. Akad. Wissenschaft., Bd. 34, p. 440. BEDOT, 1901, Revue Suisse de Zool., tome 9, p. 482; *Ibid.*, 1905, tome 13, p. 131 (list of all references from 1807–1850).

As is apparent from the above, the name *Cuvieria* was first used in botany in 1802, and in zoology for a medusa in 1807. Its previous use in botany does not interfere with its use in zoology. The type species is *Cuvieria carisochroma* of Péron from the tropical Atlantic.



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GENERIC CHARACTERS.

Thaumantiadæ with 4 principal radial-canals which branch, and the branches again branch, and all unite with the circular vessel. The gonads are developed upon the outermost branches of the radial-canals near the ring-canal. Tentacles numerous. There may or may not be marginal clubs or cirri. Development unknown.

Modern authors have commonly followed Péron and Lesueur, 1809, and Eschscholtz, 1829, in calling this genus *Berenice*, but if we follow the rule of precedence the name *Cuvieria* must stand. It is rarely a pleasant duty to revive an unfamiliar name to supplant one well known to literature, but happily in this case the name of one whose memory we all delight to honor may once more be associated with a genus in that branch of science which his labors ably advanced.

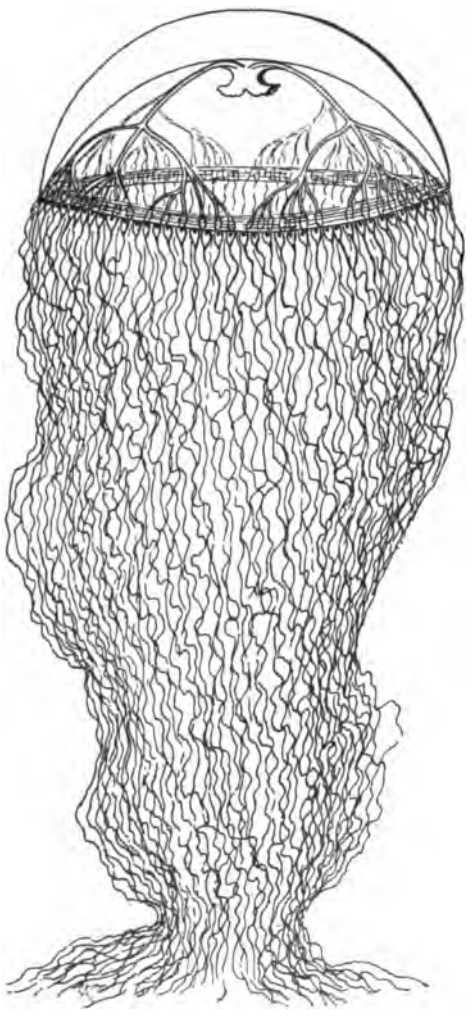

FIG. 114.—*Cuvieria "capillata"* = *C. carisochroma*, after Haeckel, 1879.

**Cuvieria carisochroma Péron.**

*Cuvieria carisochroma*, PÉRON, 1807, Voyage aux terres australes, plate 30, figs. 2, 2*a*.

*Æquorea euchroma* and *Æquorea rosea*, DE LAMARCK, 1817, Anim. sans vertèbres, tome 2, p. 497.

*Berenice rosea*, ESCHSCHOLTZ, 1829, Syst. der Acalephen, p. 120.—HAECKEL, 1879, Syst. der Medusen, p. 153.—BEDOT, 1901, Revue Suisse de Zool., tome 9, p. 482; *Ibid.*, 1905, tome 13, p. 131 (list of papers to 1850).

(?) *Berenice capillata*, HAECKEL, 1879, Syst. der Medusen, p. 154, taf. 9, fig. 5.

According to Péron, bell is flat and shield-shaped, about 50 mm. wide and 10 mm. high. There are 50 to 60 very long thin tentacles with very large, hemispherical basal bulbs. Each of the 4 principal radial-canals gives rise to two opposed side branches, and these side branches as well as the principal canals give rise to 3 to 5 terminal branches which reach the circular canal. Thus 50 to 60 canals reach the circular vessel. The 50 to 60 gonads are developed on terminal branches of canals. Bell, gonads, and tentacles rose-red, and tentacle-bulbs yellow. This species is found in the tropical Atlantic.

I am inclined to regard Haeckel's *Berenice capillata* as being identical with this medusa. According to Haeckel the bell in *B. "capillata"* is hemispherical, 20 mm. wide, 100 to 120 long tentacles, with well-developed globular, spindle-shaped basal bulbs. There are no marginal clubs or cirri.

The 4 main radial-canals and their 2 side branches each and all give rise to 4 to 8 terminal branches, so that 50 to 100 vessels reach the marginal ring-canal. Small, spindle-shaped gonads are developed upon the terminal branches of the radial-canals near the ring-canal. Stomach small, with 4 simple, recurved lips. Color (?)

Cape Verde Islands, Atlantic Ocean.

**Cuvieria huxleyi.**

*Berenice huxleyi*, HAECKEL, 1879, Syst. der Medusen, p. 154, taf. 9, fig. 4.

Bell flat, 16 mm. wide, 0.4 mm. high. 16 long tentacles with globular to spindle-shaped basal bulbs with ocelli. 80 to 100 marginal clubs, 2 to 6 between each successive pair of tentacles. Stomach small, flat, with 4 simple, short, cruciform lips. The 4 main radial-canals

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each give rise at their middle points to 2 opposite side branches. These main canals and their 2 branches each end in 5 to 7 terminal branches, and thus about 70 vessels reach the ring-canal. Gonads spindle-shaped, on terminal branches of the canals near the ring-canal.

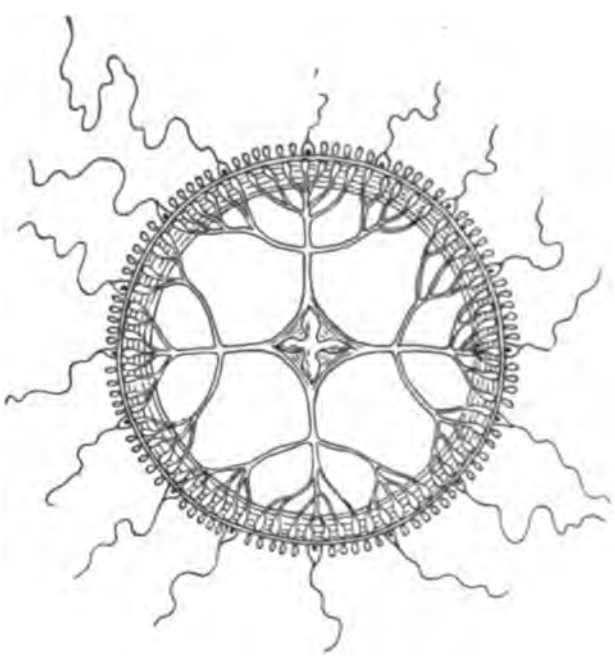
Color (?) Found off Azores, Atlantic Ocean. Distinguished by its large number of marginal clubs and few tentacles. Is it only a variety of *Cuvieria carisochroma* Péron (?).

### Genus DICHOTOMIA Brooks, 1903.

*Dichotomia*, Brooks, 1903, Proc. American Philosophical Society, Philadelphia, vol. 42, p. 11.—Maas, 1904, Sitzungsber. math.-phys. Klasse kgl. Bayer. Akad. der Wissenschaften, Bd. 34, Heft 3.

#### GENERIC CHARACTERS.

Berenicidæ with 4 main radial-canals which divide dichotomously 2 or more times and open into the circular vessel by 16, 32, or more distal branches. Tentacles of two sorts - hollow ones and solid ones—all arising from bell-margin. Mouth simple without prominent lips. The gonad encircles the stomach and extends outward over the radial-canals and their branches.



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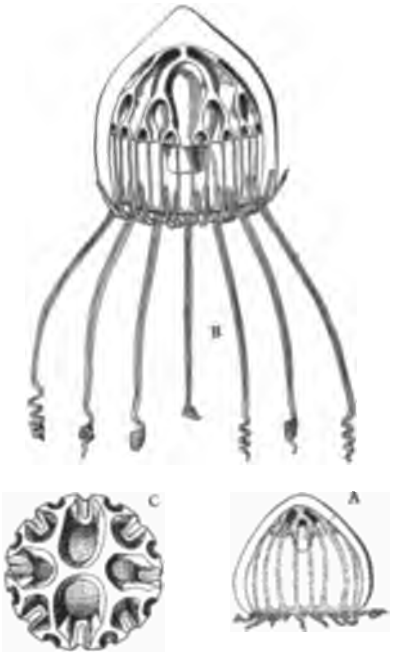


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Fig. 115.—*Cuvieria huxleyi*, after Haeckel, 1879.
Fig. 116.—*Dichotomia cannoides*, after Brooks, in Proc. American Philosoph. Soc., vol. 42.
*A*, young medusa. *B*, adult medusa. *C*, model showing arrangement of radial-canals.

The type species is *Dichotomia cannoides*, described by Brooks from the Bahama Islands. This is the only known species.

### Dichotomia cannoides Brooks.

*Dichotomia cannoides*, Brooks, 1903, Proc. American Philosophical Soc. Philadelphia, vol. 42, No. 172, p. 12, plate 1, 3 figs.—Maas, 1904, Sitzungsber. math.-phys. Klasse kgl. Bayer. Akad. der Wissenschaft., Bd. 34, p. 438.

Bell about 8 mm. high and 6 mm. wide, subcylindrical, and with conical apex. The 4 main radial-canals do not arise independently and directly from aboral end of stomach, but in pairs from the ends of a short transverse canal, so that the only planes which divide the medusa into symmetrical halves are the two primary interradial planes. When thus divided each half is bilaterally symmetrical, and the halves are reversed copies of each other (fig. 116 c). The 4 primary radial-canals branch dichotomously at least 3 times, so that 32 terminal branches

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reach the circular vessel. The radial-canals of older medusæ may branch more profusely. The subumbrella consists of two strongly contrasted regions: An upper opaque part, nearly hemispherical, contains the arches formed by the gonad, which spans space between proximal parts of radial-canals and stomach in a system of groined arches. The lower half of the subumbrella is transparent and without these arches.

There are 16 long, hollow, contractile tentacles with tightly coiled tips. In the young medusa, with only 16 terminal radial-canals, these tentacles arise from margin at base of each canal; but in older medusæ, with 32 terminal branches of radial-canals, the hollow tentacles are in the radii of dichotomy. In addition to the long, hollow tentacles, there are a number of short, stiff, solid tentacles, which remind one of the solid tentacles of Geryonidæ, and are carried turned upward from bell-margin. These short, stiff tentacles are equal in number to the terminal branches of radial-canals.

There are no marginal sense-organs, clubs, or cirri. The manubrium is a truncated cone, extending about two-thirds the distance from inner apex of bell-cavity to margin.

The gonads and manubrium in old medusæ are opaque white. The radial-canals, circular vessel, and axes of hollow tentacles in young medusæ are colored by brownish to orange pigment-granules. The bell, subumbrella, and tentacles are nearly colorless in old medusæ.

This interesting medusa was found by Professor Brooks at Nassau, Bimini, and Green Turtle Key among the Bahama Islands, and was described by him in detail.

### Genus DIPLEUROSOMA Axel Boeck, 1866, sens. emend.

*Dipleurosoma*, Axel Boeck, 1866, Forenings Vidensk. Meddelelser, Nos. 10, 11, pp. 131, 136.—Haeckel, 1879, Syst. der Medusen, pp. 155, 636.—Agassiz A. and Mayer, 1902, Mem. Mus. Comp. Zool. at Harvard College, vol. 26, p. 148.—Browne, 1898, Proc. Zool. Soc. London for 1897, p. 826; 1900, Proc. Royal Irish Acad., ser. 3, vol. 5, p. 715.

*Tetracannota*, Mayer, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 46; 1904, Mem. Nat. Sci. Brooklyn Inst. Mus., vol. 1, p. 12.

*Tetracannota + Dipleurosoma*, Maas, 1904, Sitzungsber. math.-phys. Klasse kgl. Bayer. Akad. der Wissenschaften, Bd. 34, pp. 440, 441.

*Ametrangia*, Allman, 1873, Nature, vol. 9, p. 73.

The type species is *Dipleurosoma typicum* Axel Boeck, 1866, from the coasts of Norway, Newfoundland, and northern Atlantic generally.

#### GENERIC CHARACTERS.

Thaumantiadæ with 3 or more main radial-canals, some or all of which branch irregularly (not regularly and dichotomously) and connect with the circular vessel. Gonads are upon the radial-canals adjacent to manubrium. Tentacles numerous, and marginal clubs, cirri, and ocelli may be present. The hydroid appears to be *Cuspidella*.

The radial-canals vary greatly both in number and arrangement in *D. typicum*, and are best described by Browne, 1900. This extreme variability has caused the species to be described under various names. Judging from the irregular arrangement in the single specimen of *D. pacifica* found by Agassiz and Mayer, near Tahiti, the canals may be equally variable. In *D. collapsa* they appear to be more regular, mature specimens having 16 canals arranged in 4 groups of 4 canals each.

### Dipleurosoma typicum Axel Boeck.

*Dipleurosoma typicum*, Axel Boeck, 1866, Forenings Vidensk. Meddelelser, Nos. 10–11, p. 131, fign. 1–3; *Ibid.*, *D. stuvitzi*, pp. 136, 137, figs. 1–4.—Browne, 1900, Proc. Royal Irish Acad., ser. 3, vol. 5, pp. 696, 715, plates 20, 21.—Maas, 1904, Sitzungsber. math.-phys. Klasse kgl. Bayer. Akad. der Wissenschaft., Bd. 34, p. 441.

*Ametrangia hemisphærica*, Allman, 1873, Nature, vol. 9, p. 73.

*Dipleurosoma typicum + amphithectum + irregulare*, Haeckel, 1879, Syst. der Medusen, pp. 155, 636, taf. 9, fig. 9.

*Dipleurosoma hemisphærica*, Haddon, 1885, Proc. Roy. Irish Acad., ser. 2, vol. 4, p. 526.—Browne, 1898, Proc. Zool. Soc. London, for 1897, p. 826, figs. 10–12.

Bell usually flatter than a hemisphere and about 15 mm. wide. Marginal tentacles very numerous, more than 100. Each tentacle has a bulbous base with an ocellus upon its inner side. There appear to be no marginal clubs in *D. typicum*, but these occur in *D. pacifica* of the tropical Pacific. Velum well developed. Stomach is flat and watch-glass-shaped, with an irregular outline, and there are 4 lips. In 217 specimens studied by Browne from Valencia

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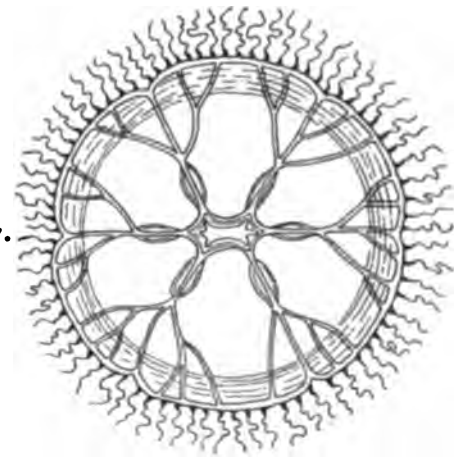
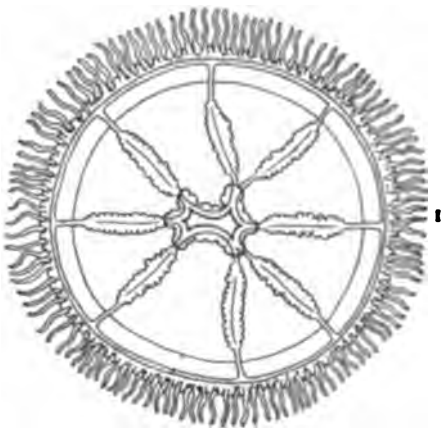
Harbor, Ireland, the number of radial-canals arising from the periphery of the stomach ranged from 5 to 18, 43 of the medusæ having 9 canals. Canals exceedingly irregular in position and in mode of branching, so that it is impossible to define a normal type, but they appear normally to connect with the circular vessel. The gonads are developed upon radial-canals adjacent to the stomach and may be upon all or on only a few of the canals. They vary in number from 1 to 12, and 5 is the most frequent number. The females are in excess of the males in the proportion of about 4 to 3. The ova remain attached to the ovary until the planula stage is reached. They were partially reared by the Misses Delap, and developed into hydroids apparently belonging to the genus *Cuspidella* (see Browne, 1900, p. 696).

The gonads, stomach, and tentacle-bulbs are said to be brownish (Haeckel, 1879).

The changes which the medusa undergoes in its growth are unknown, but Browne believes that the stomach is primarily regular in shape and that it becomes irregularly elongated into lobes by development of the radial-canals.

117.





118.

FIG. 117.—*Dipleurosoma* (*"amphithectum"*), after Haeckel, 1879.
FIG. 118.—*Dipleurosoma pacifica*, after Agassiz and Mayer, in Mem. Museum Comp. Zool. at Harvard College.

*D. typicum* of the North Atlantic may prove to be identical with *D. pacifica* from Tahiti, South Pacific. The only distinctions between the North Atlantic and the tropical Pacific species are their wide geographical separation and the presence of marginal clubs in *D. pacifica*. *Dipleurosoma typicum* has been taken off the northern coasts of Europe and off Newfoundland.

### Dipleurosoma pacifica Agassiz and Mayer.

*Dipleurosoma pacifica*, AGASSIZ A., AND MAYER, 1902, Mem. Mus. Comp. Zool. at Harvard Coll., vol. 26, p. 148, plate 3, figs. 13, 14.

Bell very flat, about 3 times as broad as high, 23 mm. in diameter. Surface of exumbrella reticulated by a regular system of hexagonal elevations bounded by shallow furrows. About 100 short tentacles with narrow, bulbular bases. Entodermal core of these tentacles is solid and composed of chordate cells. At the bases of most tentacles upon the lower (subumbrella) side, there is a single black ocellus. Slender, club-shaped, sensory bodies are scattered at frequent and irregular intervals between the tentacles. Entodermal cores of these bodies are solid and very similar to those of the tentacles. No concretions. Velum narrow. 6 radial-canals arise in groups of 3 from diametrically opposite sides of the stomach. In the single specimen examined, 2 of these canals bifurcate, and 8 canals thus reach the circular vessel. The gonads are linear and occupy the middle regions of the 8 canals. Their surfaces are slightly papillate and the ova stand out as hemispherical protuberances. Stomach elongated in the direction of the two opposed groups of radial-canals. Manubrium very short, 6 small, slightly folded lips.

Tentacle-bulbs, genital organs, and manubrium milky white, all other parts of the medusa being transparent. A single specimen was obtained in a surface haul about 50 miles north of Tahiti, South Pacific.

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*Dipleurosoma* is exceedingly variable in the number and arrangement of its radial-canals. The Pacific species is distinguished by having marginal clubs between its tentacles, these being absent (?) in the Atlantic *Dipleurosoma typicum*.

### Dipleurosoma collapsa Mayer.

Plate 27, figs. 1 to 3, and 7.

*Tetracannota collapsa*, MAYER, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 46, plates 7, 8, figs. 14–16; Memoirs Nat. Sci. Mus. Brooklyn Inst. Arts and Sci., vol. 1, No. 1, p. 12, plate 4, fig. 32.—MAAS, 1904, Sitzungsber. math.-phys. Klasse der kgl. Bayer. Akad. Wissenschaft., Bd. 34, p. 440.

*Adult medusa* (plate 27, fig. 3).—Bell 7 mm. in diameter and about as high as broad. Top dome-shaped, side walls vertical. 16 well-developed tentacles are carried tightly coiled in close helices, and besides these there are 112 very small rudimentary tentacles. Dark-brown entodermal pigment-spots are found within the base of each tentacle. There are 16 radial-canals, arranged in 4 groups of 4 each (plate 27, fig. 7). The gonads are found in proximal parts of the 16 radial-canals very near the point where they branch off from the stomach. Peduncle of manubrium wide and prominent. The mouth has 8 slightly crenated lips. Entoderm of manubrium in some specimens is green, in others it is pearly-white or yellowish. Entodermal pigment-spots at bases of tentacles are dark-brown.

*Stages in development.*—The youngest medusa observed had a bell 1 mm. in diameter (plate 27, fig. 1). It had 4 slender radial-canals and 24 tentacles, 4 well-developed and 20 rudimentary. Velum prominent; 4 lips, and as yet no peduncle. No trace of genital organs. In the next older stage (plate 27, fig. 2), we find 4 new radial-canals beginning to develop. A still older stage (plate 27, fig. 7) has 16 radial-canals and 8 lips, but as yet no peduncle and no trace of gonads, nor have radial tubes grouped themselves into 4 bundles as in the adult.

This medusa is very common at the Tortugas and Bahamas in June, and ample opportunity for observing its transformation was afforded. It exhibits the curious habit of collapsing into an almost shapeless mass, in which condition it may remain for several hours and then "straighten out" and swim about in excellent condition.

Fewkes, 1883 ("On a Few Medusæ from the Bermudas," Bull. Mus. Comp. Zool., vol. 11, No. 3, figs. 7, 7*a*), has evidently figured the young of this species under the name of "Larva of an unknown Tubularian."

### Dipleurosoma ochracea sp. nov.

Plate 29, figs. 1 and 2.

*Immature medusa.*—Bell thin-walled, somewhat flatter than a hemisphere and 8 mm. in diameter. About 12 to 16 well-developed tentacles and about 35 immature or rudimentary tentacle-bulbs. The well-developed tentacles are in the radii of radial-canals. They have hollow, conical, basal bulbs and filiform, contractile, lash-like shafts, which are about as long as the bell-radius. Each tentacle-bulb is flanked by a pair of large, sausage-shaped, marginal clubs, and in addition to these there is a single sausage-shaped diverticula from the ring-canal on the subumbrella side above each tentacle-bulb. There are no marginal cirri or appendages other than those described above. Velum very wide. Central stomach is flat and about one-fifth as wide as bell-diameter. About 6 to 9 radial-canals arise in a very irregular manner from margin of stomach; some of these give rise to side branches. Manubrium very shallow, 6 or more very irregularly arranged, folded lips with plain margins. No gonads are observed, though they may develop later upon the broad, expanded middle regions of the radial-canals. Stomach, radial-canals, and marginal clubs of this medusa are crowded with masses of yellow algæ, or *Philozoon*, apparently similar to that which infests the medusæ of *Velella*. These plant-cells develop between the cells of the medusa and give a dense, opaque, brilliant yellow coloration to the marginal clubs, and in a lesser degree to the stomach and canals. All other parts are colorless.

The medusæ are remarkable for their very active, incessant pulsation.

Large swarms of this medusa appeared at Tortugas, Florida, between July 5 and 24, 1907, but no mature specimens could be found.

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## Plate 27.

Fig. 1. *Dipleurosoma collapsa*, young medusa with 4 simple radial-canals. Tortugas, Florida, June, 1897.

Fig. 2. *Dipleurosoma collapsa*, half-grown medusa with 16 simple, separate, radial-canals.

Fig. 3. *Dipleurosoma collapsa*, mature female, with 16 radial-canals grouped into clusters of 4 canals each. Tortugas, Florida, July, 1898.

Figs. 4 and 5. *Netocertoides brachiatum.* Successive stages in the growth of the medusa. Tortugas, Florida; and Nassau, Bahamas, July, 1898 and 1903.

Fig. 6. *Netocertoides brachiatum.* Oral view of medusa shown in figure 4.

Fig. 7. *Dipleurosoma collapsa.* Aboral view of the stomach showing the grouping of the radial-canals into 4 radial clusters of 4 canals each. Tortugas, Florida.

Fig. 8. *Turris superba.* Aboral view of the stomach showing the interradial positions of the gonads.

See page 126 for description of figure 8.

Drawn from life, by the author.

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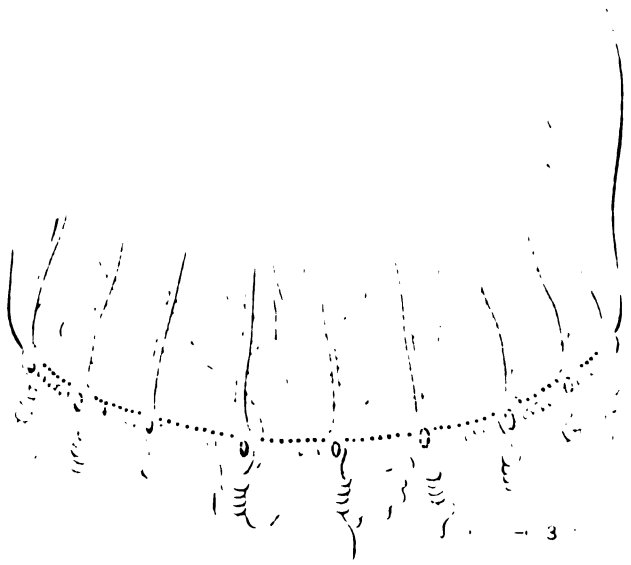

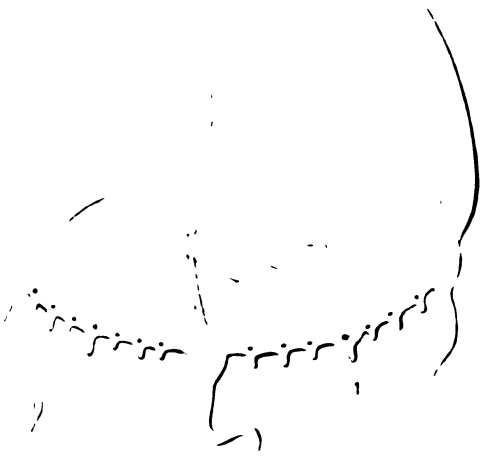

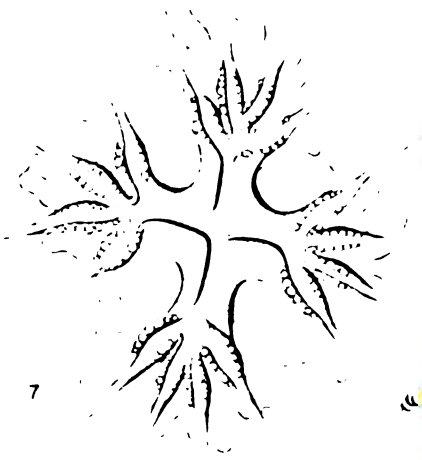

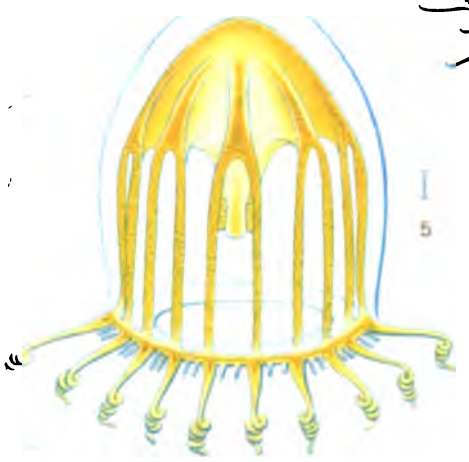

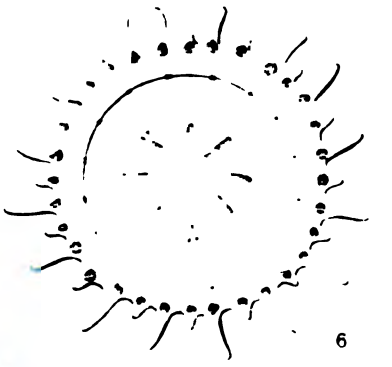

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**Dipleurosoma brooksii sp. nov.**

This form is described from drawings made by the late Prof. William K. Brooks, and found after his death among his unpublished figures. The drawings were generously presented to the author by the Department of Biology of the Johns Hopkins University for reproduction in this work.

Bell flatter than a hemisphere, evenly rounded, thin walled. Manubrium small, short, and 8-sided. 8 simple lips, 4 long and 4 short. 8 radial-canals arise from the stomach, the 4 in the radii of the long lips are trident-shaped, each giving rise to 2 side branches. The 4 canals in the radii of the short lips are simple. Thus 16 terminal branches reach the circular vessel. In the specimen figured by Professor Brooks only 14 canals joined with

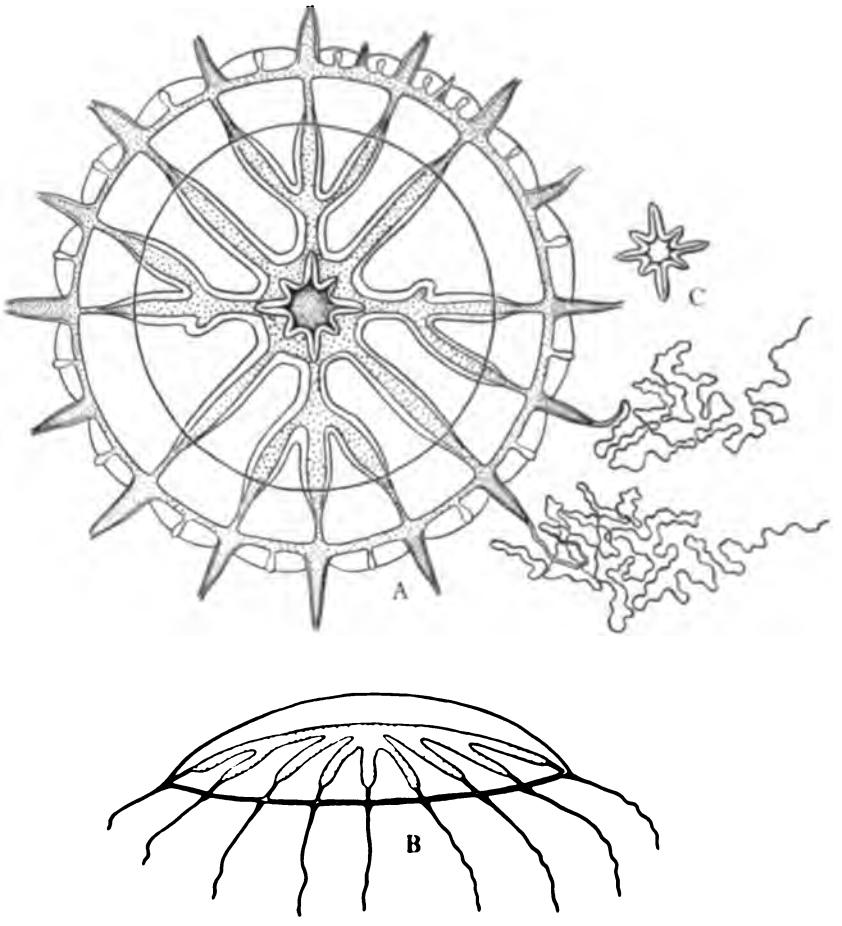


FIG. 118a.—*Dipleurosoma brooksii*, sp. nov. A, oral view; B, side view with tentacles cut off short; C, oral view of lips. Drawn from life by Professor Brooks.

the circular vessel, for two of the side branches of the main radial-canals failed to develop. There appear to be typically 16 tentacles, one at the base of each terminal branch of the radial-canals, although in two intervals there are small additional tentacles thus giving 18 tentacles in the specimen figured by Professor Brooks. The tentacles have long, conical, tapering basal bulbs, which are hollow and very long, lash-like shafts, longer than the bell-diameter and very flexible. No ocelli are figured by Professor Brooks. The gonads are upon the sides of the 16 radial-canals, not touching the ring-canal but extending from the sides of the stomach outward. The velum is a wide, annular diaphragm. The size and color of the medusa can not be determined from Professor Brooks's drawings. The medusa was found at Nassau, Bahama Islands.

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Were it not for the absence of ocelli I would be inclined to regard this medusa as a hypertrophic specimen of *Staurodiscus tetrastaurus* in which the side branches of the 4 primary radial-canals had reached the circular vessel and 4 intermediate canals had developed. I have, however, never observed such a condition among many hundreds of apparently mature medusæ of *S. tetrastaurus* found at Tortugas, Florida; and it seems probable therefore that Professor Brooks's medusa is a new species which may have been derived from a Staurodiscus-like ancestor.

### Genus TOXORCHIS Haeckel, 1879, sens. ampl.

***Toxorchis* + *Cladocanna*,** HAECKEL, 1879, Syst. der Medusen, pp. 156, 160.
***Toxorchis*, MAAS,** 1904, Sitzungsber. math.-phys. Klasse kgl. Bayer. Akad. Wissenschaft., Bd. 34, p. 441.

Haeckel, 1879, founded this genus for *Toxorchis arcuatus* of the Canary Islands, Atlantic Ocean; but the first known species is *T. thalassina*=*Berenix thalassina* Péron and Lesueur, 1809, from Northern Australia.

GENERIC CHARACTERS.

Thaumantiadæ with 4, 6, or more main radial-canals which branch regularly and dichotomously one or more times. The gonads are upon the outermost branches of the radial-canals, near the ring-canal. Numerous tentacles, cirri, and marginal clubs. Hydroid unknown.

Haeckel restricts *Toxorchis* to include medusæ having radial-canals branched once dichotomously, while his *Cladocanna* applies to medusæ having radial-canals with 2 or more dichotomous branchings.

### Toxorchis thalassina Maas.

***Berenix thalassina*, PÉRON ET LESUEUR,** 1809, Annal. du Mus. Hist. Nat. Paris, tome 14, p. 327.
***Berenice euchroma*, DE BLAINVILLE,** 1834, Manuel d'Actinologie, p. 276, plate 32, fig. 1.
***Cuvieria euchroma*, LESUEUR,** 1839, in Cuvier's Le Règne animal, plate 53, fig. 2.
***Cladocanna thalassina*+*C. polyclada*, HAECKEL,** 1879, Syst. der Medusen, pp. 160, 161.
***Cladocanna polyclada*, VON LENDENFELD,** 1884, Proc. Linnean Soc. N. S. Wales, vol. 9, p. 581.
***Toxorchis thalassina*, MAAS,** 1904, Sitzungsber. math.-phys. Klasse kgl. Bayer. Akad. Wissenschaft., Bd. 34, p. 441.
***Cladocanna thalassina*, BEDOT,** 1901, Revue Suisse de Zool., tome 9, p. 482; *Ibid.*, 1905, tome 13, p. 132 (list of papers to 1850).

Bell flatter than a hemisphere to hemispherical, about 50 mm. wide. About 100 or more long tentacles with marginal clubs and cirri between them. Stomach shallow, with 6 wide lips. 6 wide radial-canals arise from stomach. For one-third the distance between stomach and margin these canals are simple and unbranched, but outwardly they branch dichotomously and somewhat irregularly 3 to 4 times, so that there are about 100 terminal branches which reach the circular canal at the margin. The sac-like, spindle-shaped, folded gonads are developed upon the outermost branches of canals. The entire medusa is light sea-green.

Found off the coasts of New Guinea and Northern Australia. Development unknown.

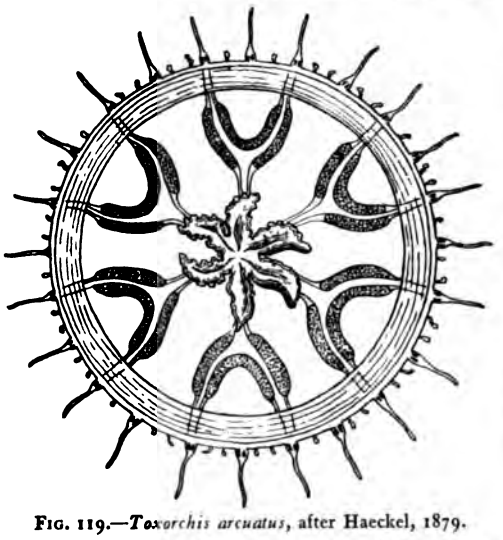

FIG. 119.—*Toxorchis arcuatus*, after Haeckel, 1879.

### Toxorchis arcuatus Haeckel.

*Toxorchis arcuatus*, HAECKEL, 1879, Syst. der Medusen, p. 157, taf. 9, figs. 6–8.

Bell flat to hemispherical, 6 mm. wide. Stomach small and flat, with 6 much crinkled, lanceolate lips. 6 main, wide radial-canals which fork at their middle points, so that 12 canals, 30° apart, reach the circular vessel at bell-margin. There are 24 long tentacles with bulbous bases, each bearing a reddish-brown ocellus. Numerous clubs and cirri on bell-margin between the tentacles.

The gonads are developed upon the edges of the forked ends of radial-canals, there being a crescentic gonad upon the concave side of the crotch of each fork, and a pair of linear gonads upon the convex sides of the forks. There are thus 3 gonads upon each main canal at its forking, 18 gonads in all.

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PLATE 28.

Fig. 1. *Toxorchis kellneri.* Side view of female medusa. Tortugas, Florida, July 8, 1907.

Fig. 2. *Toxorchis kellneri.* Oral view of the medusa.

Fig. 3. *Turris superba* (a variety of *T. pileata*). Tortugas, Florida; July 4, 1907. Mature male medusa.

Fig. 4. *Turris superba* (variety of *T. pileata*). Side view of manubrium showing the foldings of the interradial gonads.

See page 126 for description of figures 3 and 4.

Drawn from life, by the author.

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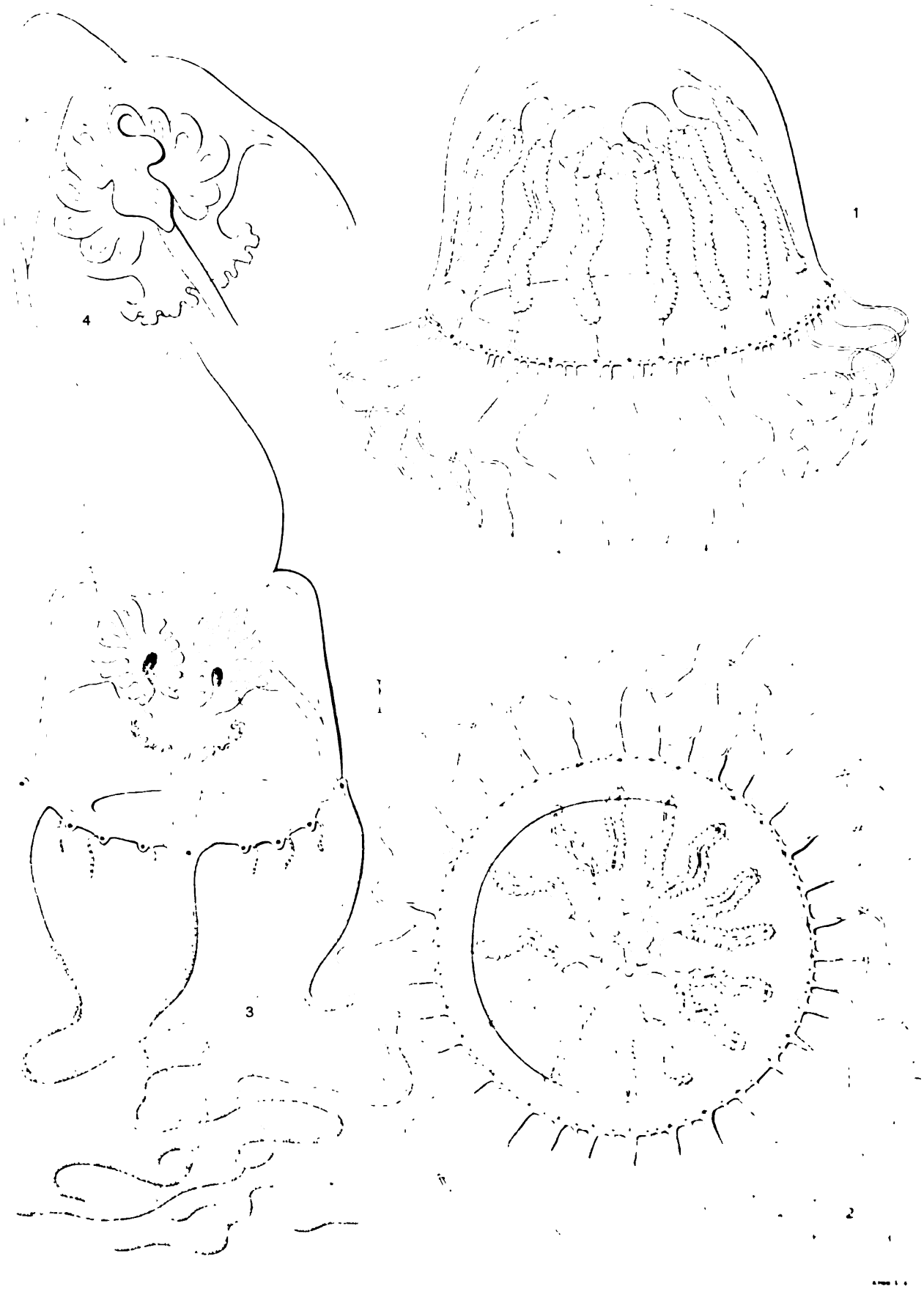


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PLATE 29.

Fig. 1. *Dipleurosoma ochracea.* Side view of an immature medusa.

Fig. 2. *Dipleurosoma ochracea.* Oral view of an immature medusa.

Fig. 3. *Stomotoca pterophylla.* Enlarged view of the medusa, showing the bell contracted so as to reduce the length of the peduncle. Nassau Harbor, Bahamas, April 20, 1907.

Fig. 4. *Stomotoca pterophylla.* Side view of the manubrium of a mature male. Off Miami, Florida, in the Gulf Stream.

Fig. 5. *Stomotoca pterophylla.* View of velum showing radial and circumferential muscle-fibers.

Drawn from life, by the author.

See page 113 for description of figures 3 to 5; page 226 for descriptions of figures 1 and 2.

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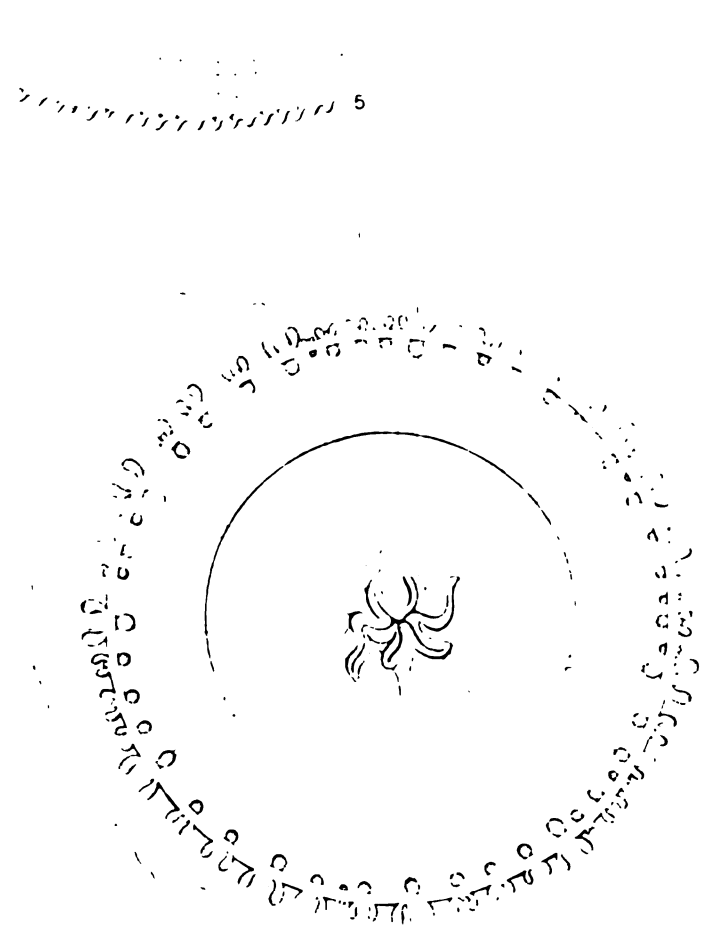

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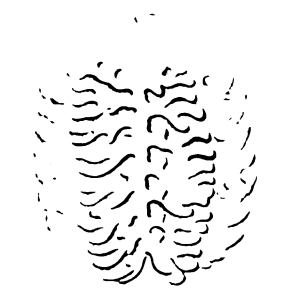

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Stomach, lips, gonads, and tentacle-bulbs are yellowish-brown, speckled with dark-red. Exumbrella besprinkled with reddish-brown spots.

Found by Haeckel at the Canary Islands, Atlantic Ocean, in January, 1867.

### Toxorchis kellneri sp. nov.

Plate 28, figs. 1 and 2.

This medusa is named in honor of the author's assistant, Mr. Carl Kellner, whose copies of figures of medusæ by previous authors appear as text-figures in this work.

Bell about 15 mm. wide, with moderately thin walls, thickest at center of bell and thin at edges. When in a normal resting state the bell is somewhat higher than a hemisphere, but when expanded it is slightly flatter than a hemisphere. There are about 32 tentacles with long, conical, tapering, hollow basal bulbs. The filiform shafts of these tentacles are highly contractile and normally 2 to 4 times as long as the bell-diameter, but may be contracted so as to become about as short as the bell-radius. There are about 50 small clubs upon the bell-margin between the tentacles; but no coiled cirri nor lithocysts. There is a black entodermal ocellus within ring-canal at base of each tentacle and marginal club.

Velum well-developed, ring-canal narrow. Stomach about one-fourth as wide as bell-diameter. 8 flat, wide radial-canals arise from margin of stomach, 45° apart. A short distance beyond the margin of the stomach most of these 8 primary radial-canals bifurcate. Thus in the specimen here figured 6 of the 8 primary radial-canals are bifurcated and thus 14 slender radial-canals reached the marginal ring-canal.

The manubrium is shallow, only about one-fourth as long as the depth of the bell-cavity, and there are 8 lanceolate lips with folded, curtain-like margins. These lips are in the radii of the 8 main radial-canals. The gonads are developed upon the sides of the narrow outer branches of the radial-canals and do not touch the ring-canal.

Central stomach pink; gonads and tentacle-bulbs brownish-yellow; entodermal ocelli very dark brown, almost black.

Several specimens of this medusa were found in a surface tow at Tortugas, Florida, on July 8, 1907. The figures represent a female.

This species differs from Haeckel's *T. arcuatus* of the Canary Islands in its higher bell, more numerous and more irregularly branching radial-canals, in the absence of marginal cirri, and in color. Unfortunately, Haeckel had but one specimen, and I have seen only three, and it is possible that future studies may show that the Canary Island medusa is identical with the Tortugas form.

## Genus NETOCERTOIDES Mayer, 1900.

*Netocertoides*, Mayer, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 45.—Maas, 1904, Sitzungsber. math.-phys. Klasse kgl. Bayer. Akad. Wissenschaft., Bd. 34, p. 437.

### GENERIC CHARACTERS.

Berenicidæ with 8 main radial-canals, which bifurcate so that 16 canals reach the circular vessel at bell-margin. There are 16 long, hollow, tapering tentacles, one at the end of each radial-canal, and 16 to 25 short, cirrus-like tentacles, one or two between each pair of long tentacles. The manubrium has 4 simple lips. The gonads are developed upon the sides of the manubrium and upon the 8 main stems of the radial-canals.

The type species is *N. brachiatum* Mayer, of the Bahamas and Tortugas, Florida. It is the only species of the genus.

### Netocertoides brachiatum Mayer.

Plate 27, figs. 4–6.

*Netocertoides brachiatum*, Mayer, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 45, figs. 43–44, plate 18; Memoirs Nat. Sci. Museum Brooklyn Institute Arts and Sci., vol. 1, p. 12, fig. 7, plate 1.

Bell 4 to 5 mm. high, miter-shaped, walls quite thin. 16 hollow tapering tentacles; one at base of each of the 16 radial-canals. 16 to 25 small tentacles, one or two between each pair of long ones. Longest tentacles about one-fourth as long as bell-height, their ends tightly

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coiled. The short tentacles are hardly more than cirri. No marginal sense-organs. Velum well developed. 8 main radial-canals arise from the manubrium, but each bifurcates, giving in all 16 terminal-canals, which extend straight toward the circular vessel. The 8 proximal roots of the radial-canals are bound to the manubrium by groined arches. Manubrium broad and disk-like. The mouth is at the extremity of a short neck, surrounded by 4 simple lips. Gonads along the main radial-canals, adjacent to the stomach. Entoderm of tentacles, radial-canals, and manubrium rosin-colored. Quite common at the Bahamas, but rare at the Tortugas, Florida. Seen only in summer.

This medusa is closely related to *Dichotomia cannoides*, but in *Netocertoides* 8 main radial-canals arise from the stomach instead of 4 as in *Dichotomia*, and the manner of branching is quite different, even in young medusæ.

### Monobrachium parasiticum Mereschkowsky.

*Monobrachium parasiticum*, MERESCHKOWSKY, 1877, Annals and Mag. Nat. Hist., ser. 4, vol. 20, p. 220, plates 5, 6.—WAGNER, 1889, Zool. Anzeiger, Jahrg. 12, p. 116; 1890, Archiv. Biologie, tome 10, p. 273, plates 8, 9 (details of histology).

This interesting hydroid has only 1 tentacle. Its medusiform gonophore belongs apparently to the Thaumantiadæ, but the free medusa is unknown, if, indeed, it be set free. The medusiform gonophore is oval and is developed in a sac which arises from the hydrorhiza. The hydroid grows upon the posterior part of the living shell of *Tellina calcarea*, near the siphon. The hydrorhiza is a flat expansion of anastomosing tubes covered with a thin chitinous membrane. The polypites are about 2 mm. long, tubular, with a single tentacle. This is 4 to 6 mm. long, tapering, lash-like, and arises from the side of the hydranth at a point about one-third the length of the polypite from the mouth. The gonophores are medusiform, about as long as the polypites, and they arise from the hydrorhiza by a short stalk. The contained medusa is oval with a short conical manubrium, 4 radial-canals, each with 2 gonads upon its sides. Ring-canal and 16 rudimentary tentacles. Color of colony, yellow. White Sea, Russia.

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